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Electrical World

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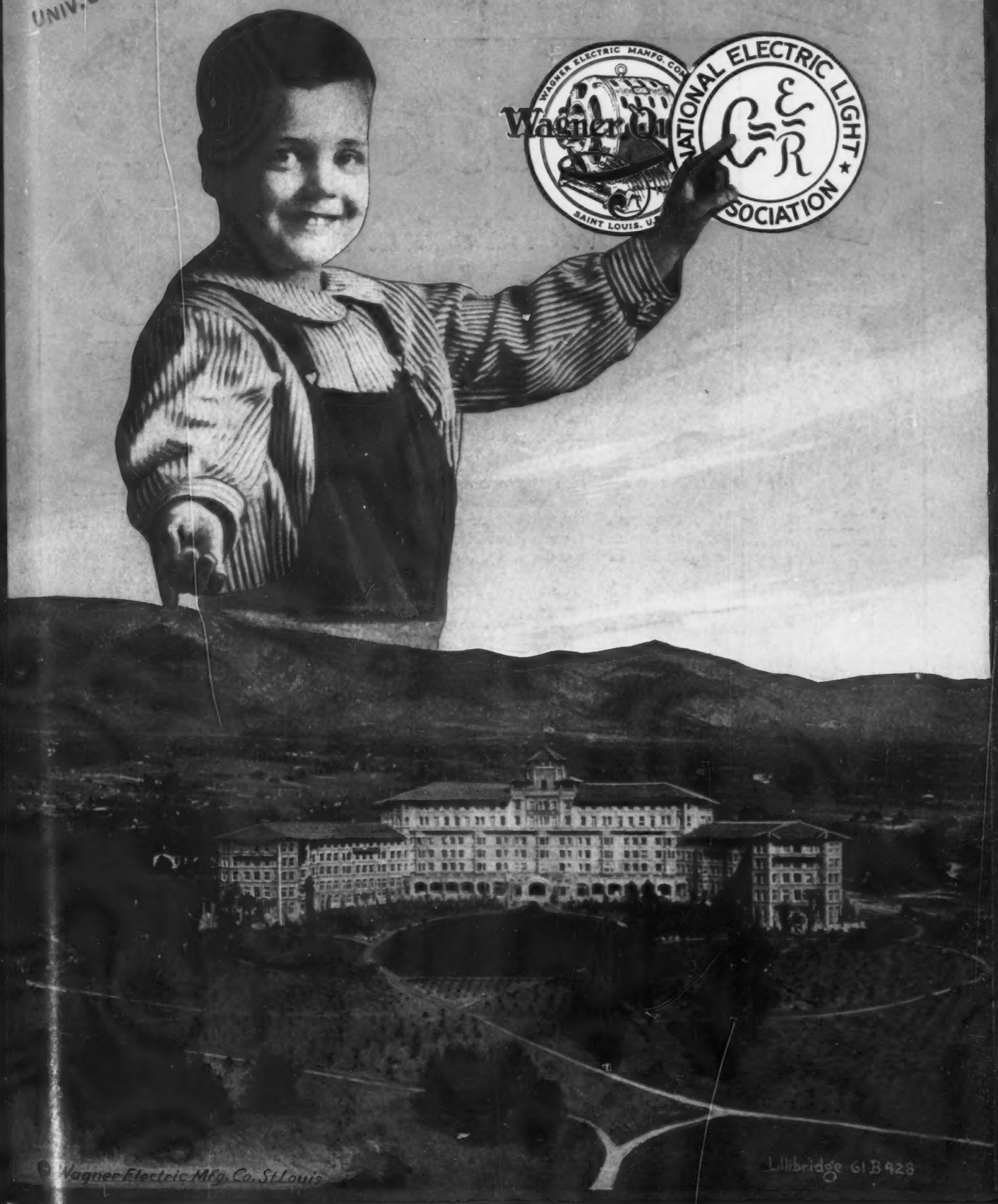
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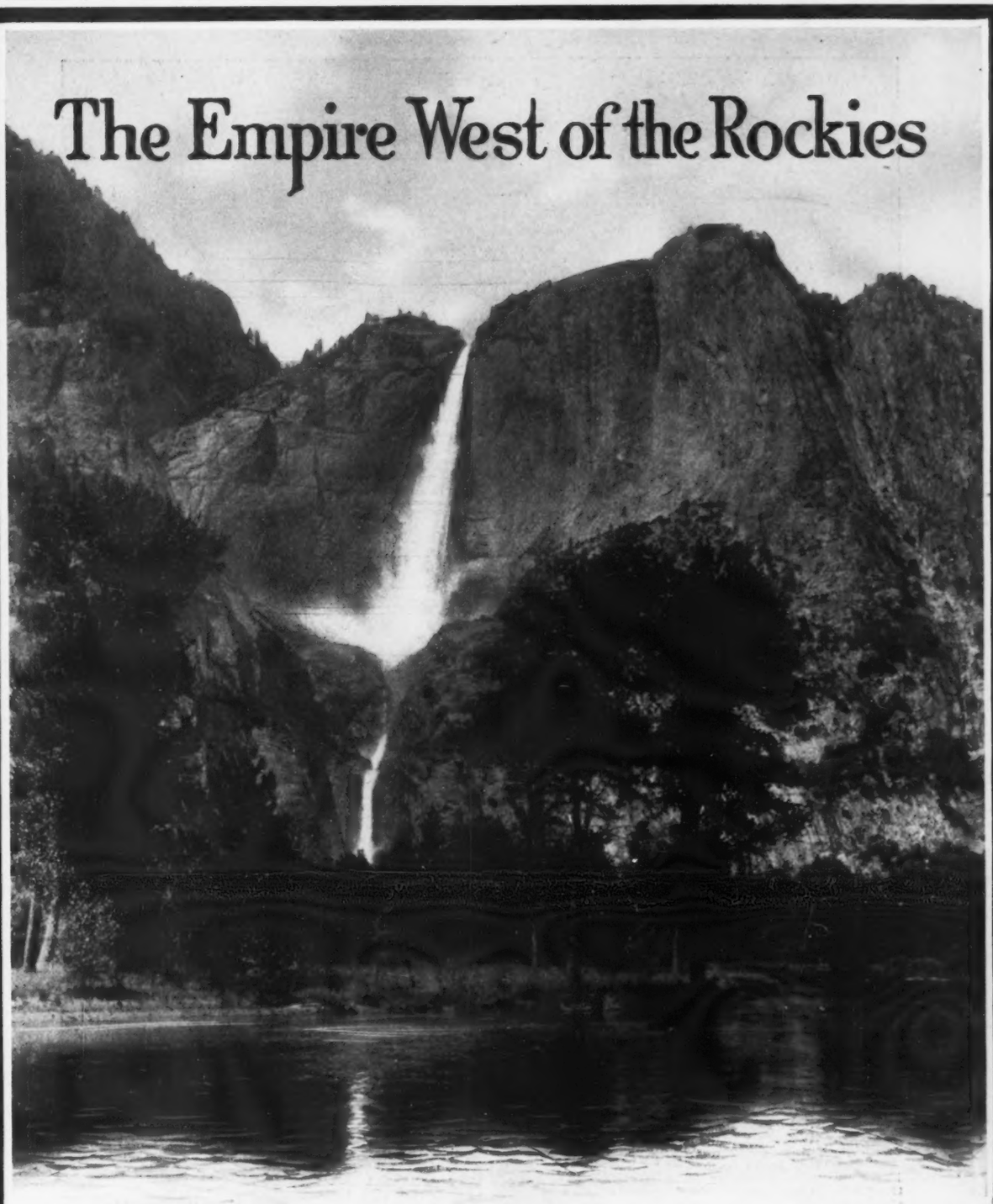
The Empire West of the Rockies



Yosemite Falls, 2,600 feet high, in Yosemite Valley, Cal.

ELECTRICITY has played a very important part in the growth of the states west of the Rocky Mountains. Hydro-electric plants supply almost all of the energy, which is transmitted over great distances at high voltages. Steam plants, where they exist, are mostly of the oil-burning type for reserve supply.

Although Portland, Ore., was the pioneer in electric transmission on the Pacific Coast, those who attend the convention of the N. E. L. A. at Pasadena will be on historic ground. The first hydro-electric station in California was a single-phase plant erected on San Antonio Creek near Pomona in 1891. This was followed shortly afterward by the three-phase plant in Mill Creek Canyon near Riverside in 1893. Further north a hydro-electric plant was erected near Folsom in 1894, from which three-phase energy was transmitted into the city of Sacramento. Since then the development of hydro-electric energy in California has been nothing short of phenomenal.

Some of the largest hydro-electric systems in the world now operate in California, notably those of the Southern California Edison Company, the Pacific Gas & Electric Company and the Great Western Power Company, with outputs aggregating 1,000,000,000 kw.-hr., 999,000,000 kw.-hr. and 450,000,000 kw.-hr. respectively. Other great systems along the Coast are those of the Portland Railway, Light & Power Company, with an aggregate output of 270,000,000 kw.-hr., and the Puget Sound Power & Light Company and the Washington Water Power Company, in the State of Washington, with outputs of 450,000,000 kw.-hr. and 241,000,000 kw.-hr. respectively. Further to the east are the great system of the Montana Power Company, supplying about 90 per cent of all of the electrical needs within Montana, and the Utah Power & Light Company system, supplying 461,000,000 kw.-hr.

Russell H. Ballard

A Californian by adoption, an ardent advocate of the electrical future of the West and an executive with a remarkable organizing faculty and ability to make friends

TWENTY-SEVEN of the thirty years Russell H. Ballard has devoted to the electrical industry have been spent in the Middle and Far West. For four years following 1890 he was a member of the Chicago office of the Thomson-Houston Electric Company. When that company was merged with the General Electric Company in 1894 he was transferred to Schenectady. During the next three years he was assigned to various branches of the company throughout the East and became intimately acquainted with the financial problems of the industry, acquiring an accurate knowledge of electrical operation and commercial policies. In 1897 an opportunity was offered to enter the accounting department of the West Side Lighting Company of Los Angeles, and with that company and its successors he has since been associated, with the exception of four years as office manager of the Butte (Mont.) Electric & Power Company. Mr. Ballard's thorough knowledge of the commercial side of the industry was properly coupled with his organizing ability when he returned to the Edison Electric Company in Los Angeles in 1904 as auditor.

With untiring energy and diligence he faced the complicated and perplexing financial and operating problems during a time when errors in judgment made serious inroads in company revenue. His determination, enthusiasm and forward thinking and his keen appreciation of public policy won rapid advancement to the position of assistant general manager of the Southern California Edison Company, and in 1917 to the vice-presidency and assistant general managership when that company and the Pacific Light & Power Corporation were consolidated. He is at present vice-president and general manager of the company. For a number of years Mr. Ballard has devoted considerable time to the problems of the industry on the Pacific Coast. He was the first president of the Pacific Coast Section of the National Electric Light Association and a leading figure in the organization of the California Co-operative League.

His election to be vice-president of the N. E. L. A. in 1915 was a recognition of his activity in all of this work. As president of the N. E. L. A. during the past year he has devoted his time unsparingly to the new departmentized organization and has not only attended and taken part in conventions of geographical sections but made extensive speaking tours in the execution of his plan to establish throughout the country territorial organizations for handling the local problems of central-station companies. In this he has met with the same success that has attended his efforts on the Pacific Coast.

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The Larger Aspects of Power Transmission

FOR the last decade we have preached, in season and out of season, the need for interconnection of power plants, thus welding together scattered systems into a coherent unit. In this week's issue we give our readers in a series of maps and articles some idea of what has been wrought to this important end. Looking at the situation thus in detail, the accomplishment has been of startling magnitude. Beginning with the northeastern portion of the country, there is an interconnected group of power transmission lines reaching from Long Island Sound to Lake Champlain and covering southern Vermont, substantially all of Massachusetts, southern New Hampshire, eastern Connecticut and Rhode Island. To the west these lines are interlinked with the Hudson Power Company, stretching far up the Mohawk Valley. The filling of one short gap would interlink the network again with the Niagara system and the Canadian lines beyond the border. Pennsylvania shows two groups of power systems, one centering about Pittsburgh, the other on the Susquehanna, reaching south to Baltimore. The New England group is not yet fully united with that in the Middle States. Beyond these, however, in the busy states of the Middle West, there are a series of important networks, especially in the states of Indiana, Illinois and Wisconsin, with an independent group of no small extent in Michigan. The ramifications of the distribution line in this great industrial territory are most complicated and far-reaching.

Interconnection in South and West

To the southward through the Piedmont country and beyond to the Alabama line and northward into Tennessee, on the other side of the Appalachians, runs a great industrial network with many branches and many power stations. It reaches from Goldsboro, N. C., on the east to Nashville, Tenn., on the west, as the lines cover more than 700 miles (1,120 km.). It is not yet linked with the important system in northern Alabama, reaching from Sheffield on the north to Opelika on the south. West of the Mississippi lies a great unspanned stretch of farming country not rich in hydraulic resources. Not until one reaches the Rockies does the scene change. Colorado, one of the earliest fields of power transmission, presents a group of isolated plants, Utah another group, for the main part united, centering about Salt Lake City. To the north, in the busy mining country of Montana, ramifies the great system of the Montana Power Company with its heavy industrial loads and splendid railway electrification. So remarkable are the hydraulic resources here that the network is operated without steam reserve. It reaches westward into Idaho and needs but a very short span to connect it with the Washington power group, which ends only on tidewater in Puget Sound. Southern Idaho has a system of its own along the Snake River as yet unconnected with the eastern group or the Utah system. Eastern Oregon is covered independently, although soon to be linked with the Washington system, and then to the southward begins that prodigious series of developments in California with which our readers are familiar, at one extremity stretching across the border into southern Oregon and at the other ending only at the Mexican border. Yet these vast systems of high-voltage transmission lines, interconnected with many ramifications from end to end, built up of the work of many companies, utilize hardly more than one-fifth of the available water power along the Cascades and Sierras.

The Greater Things Yet to Come

Surely all this constitutes a prodigious feat in utilizing the forces of nature. None the less there is another side to the story of which we must speak in looking forward to the future. These interconnections of allied systems, great as is their usefulness in assuring somehow continuity of supply, are upon the whole and in the main not fundamental but auxiliary. They do not yet touch the biggest things in the electric transmission of power. The exchange of energy between independent watersheds, the seasonal interchange of great blocks of power, the winning of a combined diversity and load factor—to accomplish these great results requires far more than linking together the extremities of existing lines. It implies treating the whole area of distribution as a fundamental unit with trunk lines to insure the full balancing of the load, such trunk lines as have been over and over again suggested but never yet built. They must sometimes cover hundreds of miles, with capacity reckoned by the hundred thousand horsepower, to take full advantage of the varying needs and varying water supplies. They must link regions of different storage facilities, as they would in California, or of different periods of effective rainfall, as between the Rockies and Puget Sound, or bind together hydro-electric plants and those built at the mouths of coal mines, as they might well do along the eastern coast. Today the gains from interconnection, great as they are, are chiefly local gains. Take, for example, the far-flung Southern system, reaching from the Mississippi Valley to the coast, in theory 700 miles of united transmission line, in practice only a small amount of power interchanged between end and end.

Even California, far to the front in power develop-

ment when one considers the number of plants and intricate networks, presents two natural independent distributions very loosely linked. A full regard for the conservation of water demands that the whole hydraulic resources of the Cascades and Sierras be so tied together as to make the most of the combined storage facilities of nature and art. It is not necessary or desirable that the nearly threescore plants which contribute to the colossal total should all be in simultaneous operation. They need to be run as conjoint requirements of storage and of irrigation demand. In the long run not a few of them may be evolved into automatic or semi-automatic stations brought into play when they can best serve the interests of the whole. And so the story goes elsewhere in the country. The Snake River plants, the Montana system and the Washington system are close enough together and to the Utah group to link into unity the watersheds of the Pacific Coast and the Rockies. Along the Atlantic seaboard the trunkline project already outlined gives play to the imagination, affording a vision of New York City, Niagara and the Pennsylvania coal mines tied into an invincible triangle. By Niagara we do not mean the driblet of power now accorded, but something like the full resources of the great cataract.

All these things to be achieved are not to be reckoned with in years, but in decades or generations. As year by year we come more and more to realize the grim limitations of the stored fuel with which we have played spendthrift, things which now seem the unsubstantial phantoms of a dream must become realities. The loss year by year of the power raised skyward by the sun to run unused into a thankless sea is the only irrevocable loss which civilization knows. It is high time that this loss were converted into gain.

Commissioner Edgerton's Views on Public Utility Financing

MEN supposedly of light and leading are frequently lured into print to discourse with an air of finality on politics, the contentions of capital and labor, the relations between utilities and the people and other public questions. Too often, however, the expectant reader, seeking guidance amid partisan noise and confusion, learns from their outgivings nothing more than that honesty is the best policy, that there are two sides to everything, that friendliness makes friends, that extremes in any direction should be avoided, or that rights and duties are reciprocal. When pressed for advice men in authority are prone to emulate the katydid of Oliver Wendell Holmes and say undisputed things in such a solemn way that they pass momentarily for chunks of original wisdom, though when examined they take on the triteness of bewhiskered platitudes.

From such exhortations and counsels of perfection it is pleasant to turn to the concrete suggestions made elsewhere in this issue by the chairman of the California Railroad Commission concerning the proper financial regulation of public service companies. Mr. Edgerton wastes no space on generalities that age has deprived of power even to glitter, but, laying down the axiom that public utility securities are necessarily of the conservative and not the speculative type, makes four proposals for establishing a proper relationship between securities, rates and profits in order to attract needed capital and promote its successful use.

He advocates in the first place that the present intricate method of basing rates on plant valuation be abolished and that instead rates be placed at a figure sufficient to pay dividends and interest on outstanding capitalization sanctioned by the commission; second, that, to prevent constant fluctuation in rates, the companies be permitted to accumulate a cash reserve when earnings are high to tide them over periods of temporary decrease in revenue; third, that the companies and their customers shall share increases in earnings due to efficient management, thus providing the incentive for the exercise of executive ability that is lacking when profits are absolutely fixed, and, fourth, that there be financial co-operation between utilities of the same kind, even to the extent of indorsing one another's securities and consulting one another as to the amount of the obligations and the time of their issue.

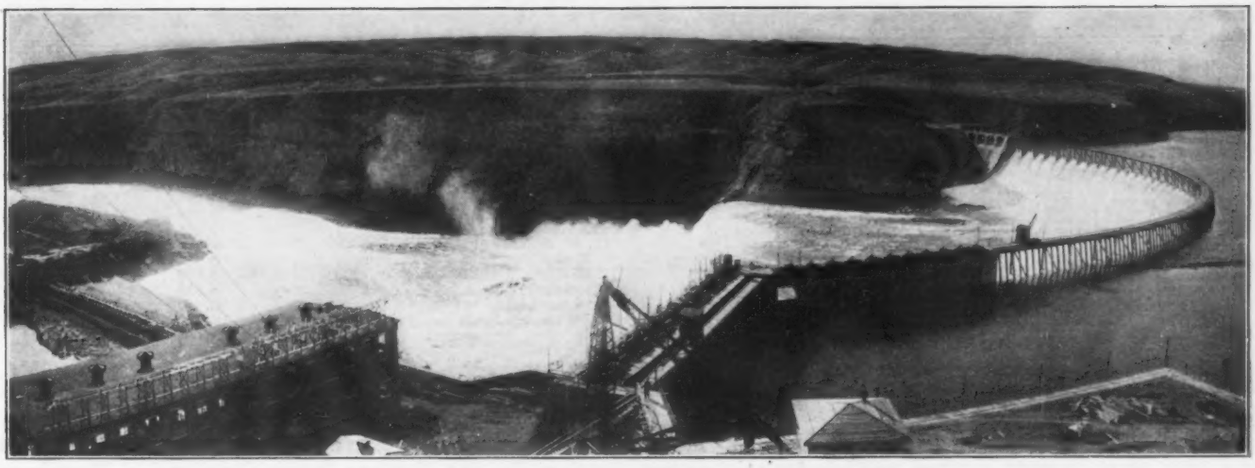
Capitalization and Rates

Mr. Edgerton's first and most important proposal runs directly counter to existing practice. In fact, among the court decisions summarized in last week's ELECTRICAL WORLD was one by the Colorado Supreme Court, which, in passing on a case that had been before the Public Service Commission of the State, expressed the opinion that outstanding capitalization should have little influence on rates in view of the common practice of watering stocks. Mr. Edgerton's answer to this obvious objection is that where overcapitalization exists it would have to be reduced in accordance with the decision of the commission and that the companies could have the option of agreeing to such a reduction or continuing under the present rate-making system. We presume that in arriving at the proper capitalization for any company a valuation of its physical property would be made and thus there would not, after all, be an elimination of that laborious process; but if the public mind could be made confident that all water had been squeezed out of the stocks and bonds, the method of rate fixing favored by the commissioner would have a great point in its favor.

Mr. Edgerton's second proposal, for a cash reserve, seems a wise one in view of the impossibility of insuring a revenue that will not fluctuate from unforeseen and unescapable causes. His third contention, for a division of managerial profits, is along the line of universal practice in other businesses than those of public convenience and necessity; for in what manufacturing or mercantile establishment are all the gains from careful management or executive ability handed over to the customers? Nothing, indeed, is surer than that care and skill which bring no reward will sooner or later cease to be exercised to their utmost.

Co-operation in Finance

There remains Mr. Edgerton's fourth proposition—for financial co-operation among utilities. This is primarily a question for the companies themselves to determine, and to their thoughtful consideration it may be commended. Such co-ordination as he suggests has, among large-company combinations, the novel aspect, from the popular point of view at least, of being clearly in and not against the public interest. Indeed, the commissioner's whole plan as outlined in his article foreshadows invitingly an era of harmony and mutual satisfaction, when utilities will be content with their profits and customers with their bills—an era of understanding, of fair dealing on both sides and of public control in just the right degree by men conspicuously fit.



POND ABOVE THOMPSON FALLS DAM THAT DEVELOPS 30,000 KW.

What Interconnection Has Done for Montana

The Montana Power Company, with Thirteen Hydro-Electric Plants and No Steam Reserve, Assures Continuity of Service to Mines, Smelters, Refining Plants and Railroads at Lowest Average Price in the Country

ELECTRIC service can be pointed to as the agent that has made Niagara Falls the great electrometallurgical and electrochemical center and as the very lifeblood of comfortable existence in California, but few persons probably realize how vital a factor it has been in Montana in fostering the native industries and making it possible for them to be carried on more economically than would be possible otherwise.

Prior to 1912 electric service was furnished by several independent companies not co-ordinated, but since that time the Montana Power Company has consolidated and unified the systems by tying together the generating plants and operating them as a whole rather than as separate entities. Unlike many systems that have been formed out of several old ones, the Montana system has been laid out with future development in view, the transmission network being arranged to take care of almost any industries that may develop and to permit ready connection with new hydro-electric plants that may be constructed. Not only have provisions been made for assuring almost absolute continuity of service, but energy is supplied at the lowest average rate per kilowatt-hour offered by any company doing a similar business. The company claims as well the highest energy consumptions per capita. The system is also peculiar in that it operates without any steam reserve.

In the application of electricity to extensive mining operation Montana has easily assumed first rank, and the energy obtained from distant water power is being conducted to remote places, difficult of access, where it performs an infinite variety of work in a most economical and efficient manner. So satisfactory have been the results that electricity has practically superseded steam power and is now driving enormous hoists, compressors, pumps and other mechanical appliances used in the gigantic mining, reduction and refining operations at Butte, Anaconda and Great Falls.

In the electrification of railroads Montana has secured first place. Starting with the electrification of the Butte, Anaconda & Pacific Railway, with its 90 miles (144 km.) of track, the Montana Power Company next electrified the Chicago, Milwaukee & St. Paul Railway, which has 450 miles (724 km.) of its electrified track in Montana.

Even coal mines, which would be expected to be able to develop power as cheaply as it could be done, are served extensively with electricity from this system. Not a single flour mill—and there are many in this great wheat region—is operating on any power but what is furnished by the Montana company. While electric service has made industry in Montana, it in turn has been made available at the attractive rates offered because the demand has been in large blocks and not in small, widely scattered units.

Importance and Nature of Industrial Loads

Based on their connected loads (see Table I) the industries which take chief rank are, first, smelters, including electrolytic and electrometallurgical processes, and, second, electrified railroads. Mines, irrigation and pumping of all kinds, cement works and rock crushers, mine mills, railroad shops and flour mills also provide very important loads. While copper is the principal metal mined, market prices are making it attractive to devote considerable attention to silver, zinc and ferromanganese. In fact, the increased activity in connection with these materials has appreciably offset the slump in the copper business. The copper and zinc mines in the Butte district use electricity almost exclusively, while the smelters of the Anaconda Copper Mining Company and American Smelting & Refining Company employ it entirely.

To give some idea of the nature of some of the most important loads, nine have been listed in Table II, with their average and maximum demands for one day. It

TABLE I—DIVISION OF CONNECTED LOAD IN 1919

		Horsepower
Commercial arc and incandescent lighting		25,470
Domestic heat applications and electrical appliances (principally electric ranges)		13,306
Commercial power		266,657
Smelters	95,419	
Electrified railroads (motor-generators)	71,005	
Mines	69,223	
Irrigation and pumping	7,532	
Cement works and rock crushers	4,256	
Mine mills	2,844	
Railroad shops	2,697	
Flour mills	2,685	
Miscellaneous		10,477
Total		315,910

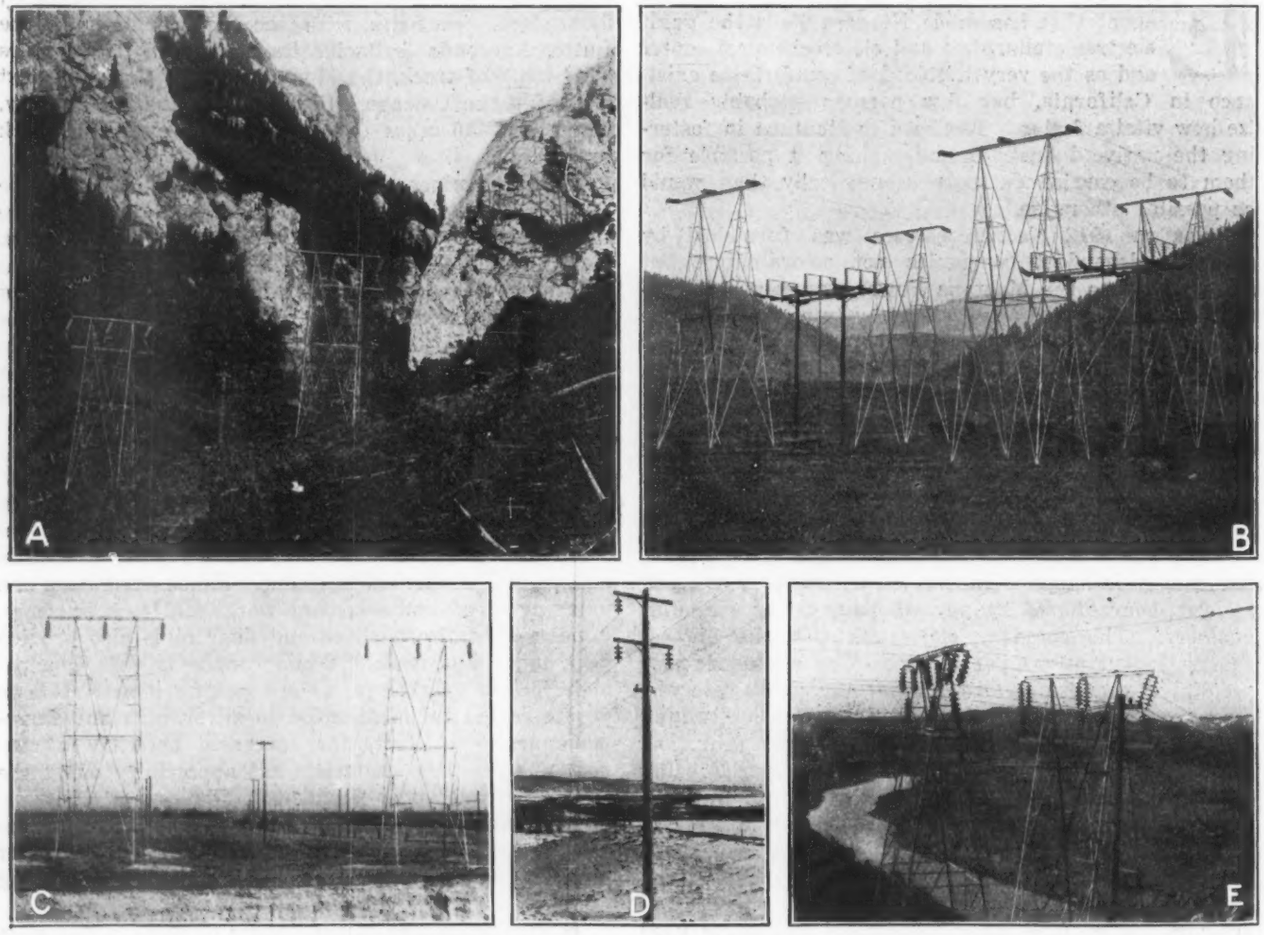
TABLE II—NATURE OF PRINCIPAL LOADS
(System load factor 93 per cent, March 13, 1920)

Industry	Load (Kw.) Average	Max.	Load Factor Per Cent
Great Falls zinc plant	31,083	31,500	99
Butte mining load	30,250	35,000	86
Anaconda copper smelter	17,458	19,400	90
C., M. & St. Paul electrification:			
Rocky Mountain division	9,450	16,000	59
Missoula division	9,000	14,000	64
Electrolytic copper	4,530	5,200	87
Ferromanganese *	5,950	7,900	75
Butte miscellaneous power and lighting	6,312	8,000	79
Butte, Anaconda & Pacific electrification	1,458	4,400	33
	1,316	5,000	27
Coeur d'Alene Mines	5,100	6,200	82

* Only two furnaces working; five eventually will give still better load factor.

is interesting to note the very high load factors of the zinc plant, copper smelter and electrolytic copper plant, ranging from 99 to 87. Mining ranks closely as a business with high load factor, while the load factor from railroad electrification ranges from 39 per cent for the Butte, Anaconda & Pacific Railway to 60 per cent for the Chicago, Milwaukee & St. Paul. Miscellaneous power and lighting gives a load factor of 79 per cent. While the load factor of the ferromanganese furnaces is only 75 per cent at present, it will be considerably higher when more furnaces are working to give a greater diversity factor. The load factor of the Montana Power system on the day to which the foregoing figures refer was 93 per cent.

Some persons may contend that the copper mines could operate without electric service from a large system like the Montana Power Company's. They have done so and they could still do so, but not at the power cost which electric service from this system makes possible. Power cost would not be so important to some industries, but copper mining, smelting and electrolytic refining require considerable energy per ton of output and the price of power is an important factor. By reason of the low energy rate available to all, the mines can afford to work up closer to the rock facings than they would otherwise do and hence are able to remove copper that would otherwise be left in the mines. The gold dredges, particularly, are benefited by electric service, not only because no individual could generate electricity so cheaply as the public service company but



TYPICAL TRANSMISSION LINES IN MONTANA

A—Great Falls-Butte transmission line in Beaver Canyon. B—Outdoor switching on 100,000-volt line. C—Double-tower 100,000-volt line near East Helena. D—Typical 50,000-volt line on wood poles. E—Great Falls-Butte line crossing the Missouri River.

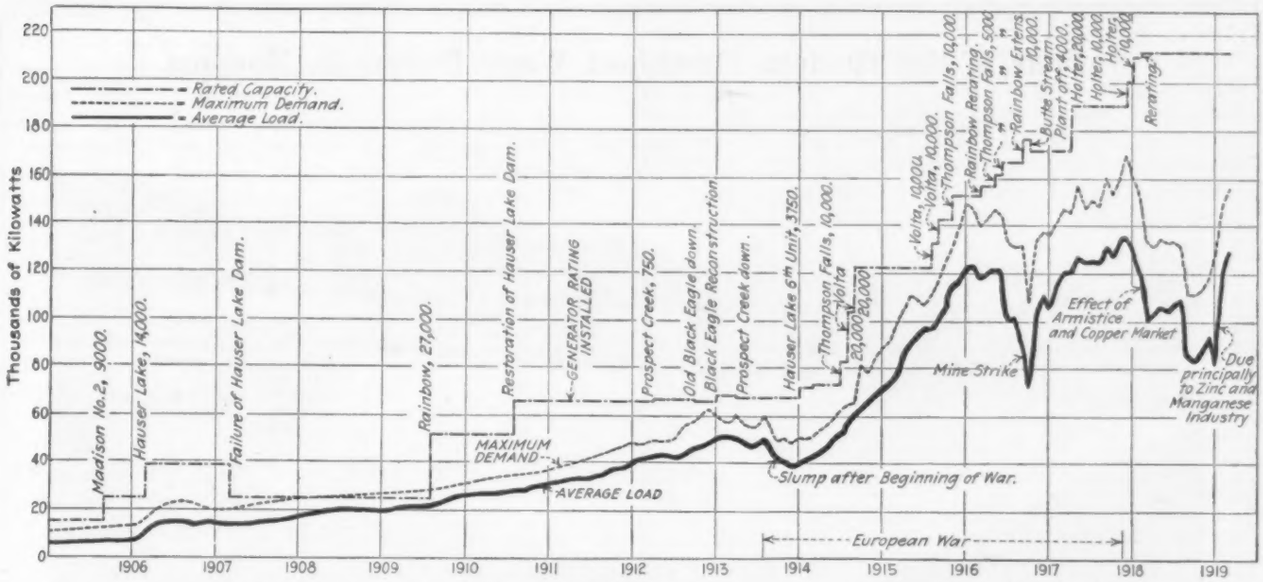


FIG. 1—SUPERIMPOSED MONTHLY PEAK AND AVERAGE LOADS AND STATION CAPACITY (1905 TO DATE)

It will be noted that this average load curve is almost a historical picture of industrial development. The effect of the war, the strike and the zinc and manganese industry are very evident.

because the handling necessary to place coal on the dredges adds to the unit cost.

The value of electric service to industries in Montana is well illustrated by the following example: A large coal-mining concern at Roundup equipped itself with a modern turbo-generator station. After running the plant for a considerable time and keeping accurate records of the costs it decided to salvage the plant and buy energy from the Montana Power Company. Since then it has greatly increased its production per dollar spent for power. This coal mine is not the only one which has found it more economical to give up an isolated plant. Every coal mine in Montana, except one group which cannot be reached economically by a transmission line, is using central-station energy.

As a result of electrification both the Butte, Anaconda & Pacific Railway and the Chicago, Milwaukee & St. Paul are saving money per ton-mile transported, hauling larger loads per train, saving in locomotive maintenance, reducing delays, increasing schedule speed, and thereby getting along with less rolling stock than would be the case with steam locomotives. Aside from these advantages, they have been able to dispense with water tanks and coal docks and have got rid of the trouble they used to meet in braking. The train hands are better satisfied, freight is not so easily stalled, passengers are pleased, and numerous other advantages accrue. With the great increase in the price of coal the advantages of electrification over steam operation have multiplied.

RELATIVE POSITIONS AND FEATURES OF HYDRO-ELECTRIC STATIONS

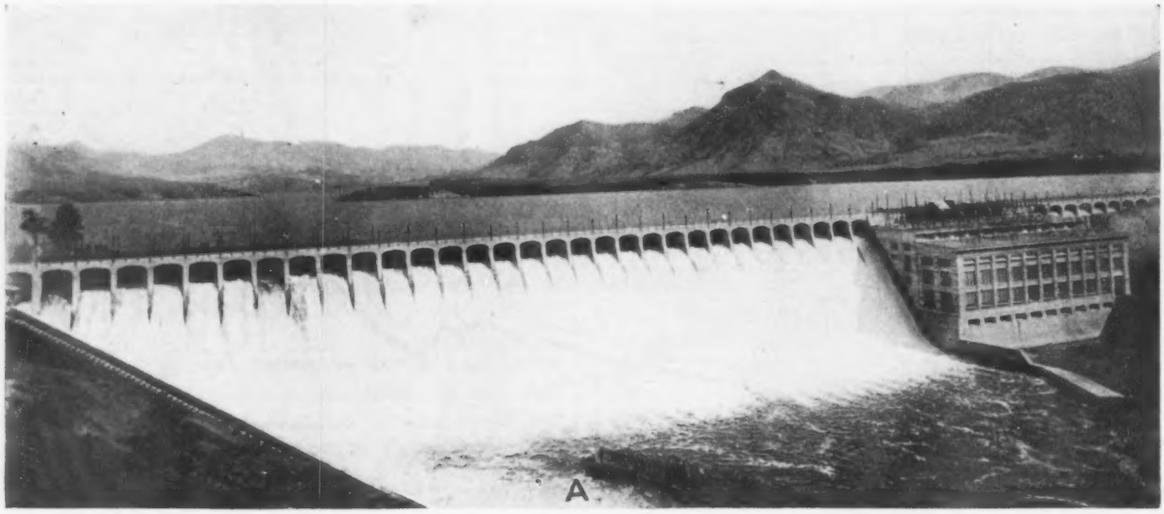
To serve these industries the Montana Power Company is operating thirteen hydro-electric plants with a combined rating of 212,340 kw., distributed as shown in Table III (see map on page 1056). Some of the plants can operate at full load all year; others have considerable reserve for daily peak loads. Thompson Falls, on the Clark Fork of the Columbia River, is over on

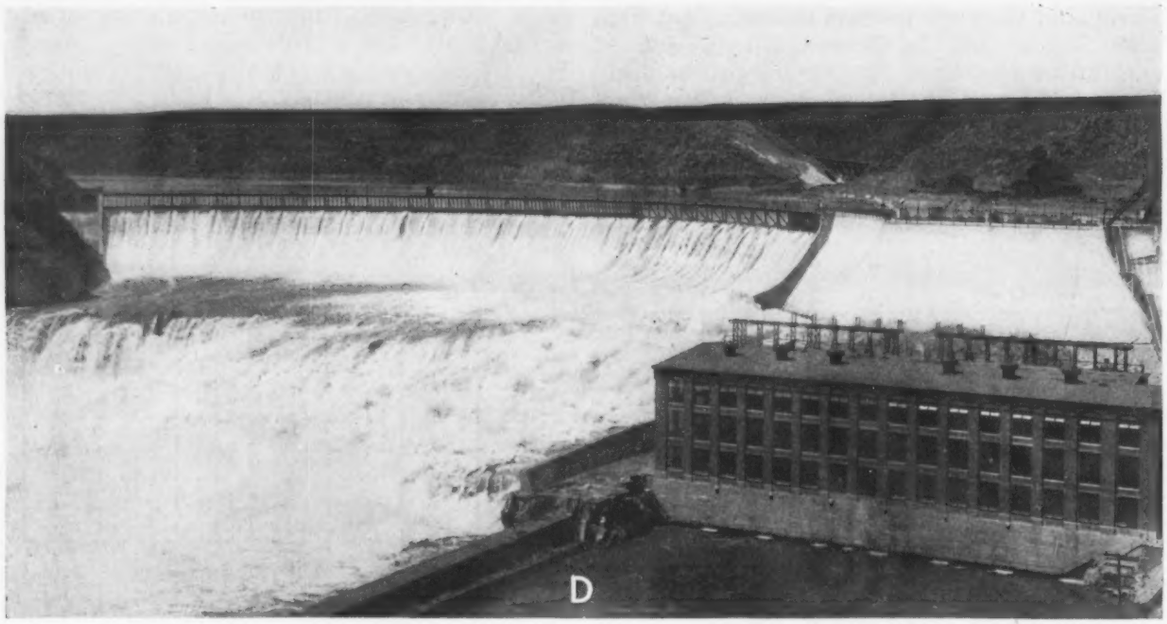
TABLE III—OPERATING DATA REGARDING HYDRO-ELECTRIC PLANTS FOR YEAR 1919

Name of Plant	Year Completed*	Rating Kw.	Average Head, Ft.	Storage, Acre-Ft.	Dam		Average Water Flow (Sec.-Ft.)		Kw. per Sec.-Ft.	Load Factor	
					Height, Ft.	Length, Ft.	Available	Used		1919	Theoretical with System Fully Loaded
Great Falls	1916	60,000	150	3,000	72	1,250	4,487	3,147	9.00	48	56
Holter	1918	40,000	103	73,000	100	1,350	3,622	1,534	6.70	19	41
Rainbow	1910 & 1916	35,000	111	1,000	36	1,145	4,487	3,221	6.40	53	80
Thompson Falls	1916	30,000	56	4,200	35	1,000	15,809	5,458	....	45	..
Hauser Lake	1911 & 1914	18,000	65	46,000	65	720	3,430	2,432	3.66	56	66
Madison No. 2	1906	10,000	108	36,000††	44	183	1,651	944	6.70	63	100
Canyon Ferry	1891 & 1901	7,500	34	40,000	40	490	3,431	2,194	2.13	35	61
Black Eagle	1913	3,000	43	....	18	745	....	852	2.50	56	100
Big Hole	1898	3,000	60	†	...	....	....	....	....	10*	..
Madison No. 1	1901 & 1907	2,000	55	....	...	....	....	....	3.35	6**	100
Livingston	1906 & 1908	1,500	24	None	...	....	....	....	....	59	..
Billings No. 1	1907	1,080	17	None	...	....	....	....	....	76	..
Lewiston No. 1	1906	450	62	....	...	....	176	66	.....	64	..

* Big Hole did not operate during February, March, April, May and September.
** Madison No. 1 operated only 544 hours during year.
† Sufficient for daily variations in load.
†† Does not include 325,000 acre-ft. in Hebgen Reservoir just above plant.

Four of the Thirteen Developed Water Powers in Montana





A—Holter, the newest and second largest plant, with a storage of 73,000 acre-ft., provided by a dam 100 ft. high by 1,356 ft. long. B—Canyon Ferry, the oldest plant, having a storage of 40,000 acre-ft. C—Hauser Lake, an 18,000-kw. plant with 46,000 acre-ft. storage. D—Great Falls development, 60,000 kw., the largest on the Montana system.

the western edge of Montana, but in a very convenient position to serve the western end of the Missoula division of the Chicago, Milwaukee & St. Paul Railway and the Cœur d'Alene mining district in northern Idaho. The Livingston and Billings plants are on the Yellowstone River, Lewiston on Big Spring Creek, a tributary of the Missouri. Big Hole is on the river of the same name, Madison Nos. 1 and 2 are on the Madison River, which empties into the Missouri, discharging water through Canyon Ferry, Hauser Lake, Holter, Black Eagle, Rainbow Falls and Great Falls. Thus the last eight plants all benefit from Hebgen reservoir, on the Madison River, just above Madison No. 1, with its storage of 325,000 acre-ft. (399,750,000 cu.m.) and utilize the same water except for what may drain into the river between plants. These plants serve the bulk of the industrial load around Butte, Anaconda and Great Falls. Although Big Hole, Livingston, Billings and Lewiston can contribute their share through the interconnections provided, they are principally to serve loads on the outskirts of the Montana power system.

Great Falls station, which has the highest rating, 60,000 kw., and highest head, 150 ft. (45 m.), of all the plants on the system, is one of the modern installations, having been completed in 1916 (See Table III). While it has only 3,000 acre-ft. (3,690,000 cu.m.) of storage immediately available, it is below all other plants on the Missouri River and hence can utilize all water passing through them as well as take advantage of their storage, which amounts to 524,000 acre-ft. (536,000,000 cu.m.), including the Hebgen reservoir. Of course it takes time for the water from upstream reservoirs to reach it (about two days from Holter and seven days from Hebgen), but the storage at Canyon Ferry, Hauser Lake and Holter is great enough—169,000 acre-ft. (207,000,000 cu.m.)—to carry the maximum rating of this plant until water from Hebgen reservoir reaches it. Usually peak loads are taken first by the three plants above, and when the water reaches Great Falls the load is shifted or shared with this and other plants in its vicinity, namely Black Eagle and Rainbow. Great Falls has six vertical single-runner wheels driving 10,000-kw., 6,600-volt generators, from which the voltage is stepped up to 100,000 volts.

HOLTER—THE NEWEST PLANT.

Holter, the newest station of the system (completed in July 1, 1918), is next in rating (40,000 kw. to 50,000 kw., depending on operating conditions) and has the largest individual storage, 73,000 acre-ft. (89,700,000 cu.m.), with the exception of the Hebgen reservoir. It also has the highest and longest dam, its height being 110 ft. (33 m.) and its length 1,350 ft. (411 m.). Simplicity is the principal feature of the plant. It is built on the downstream face of the dam, thereby reducing substructure expense and simplifying the penstocks. Four vertical single-runner waterwheels drive 12,500-kw., 6,600-volt generators. Whereas double buses and the corresponding complement of switching were used in some of the earlier plants, Holter employs single high-tension and low-tension buses. Each generator is connected through an oil sv itch and disconnecting switches with a step-up transformer. Any generator may also be connected with a 6,600-volt bus to feed through some other transformer if necessary. The high-tension bus makes it possible for any transformer to feed through any outgoing line. The switching positions are normally such that each generator and its transformers feed one line. Both of the buses contain sectionalizing switches, and a tie containing an air-break start switch is provided between the two principal out-going lines, making the system still more flexible. This is the first plant on the system to use three-phase transformers, the units being rated at 12,000 kw. to 16,000 kw. The transformers are on the same level as the generators, the 6,600-volt switches are on the mezzanine floor, the 100,000-volt switches are on the next floor,

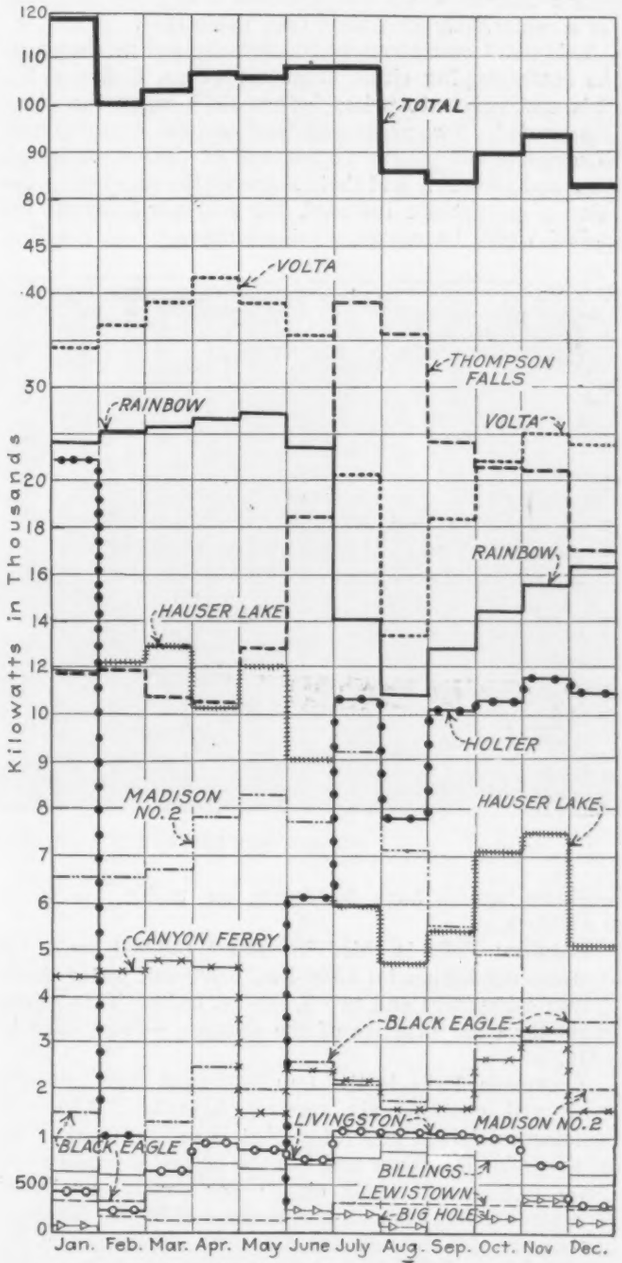


FIG. 2—AVERAGE MONTHLY OUTPUT (KW.) OF STATIONS AND TOTAL FOR 1919

Volta, the Great Falls station, delivered the greatest amount of power during the first half of the year and less the second half, although the output increased toward the end of the year. Rainbow Falls was operated in a similar manner. Thompson Falls' output was weak the first half, strong during the middle of the year, but declined again toward the end. Hauser Lake was strong the first half but weak the last half. Canyon Ferry's output was strongest the first four months, and weak the remainder of the year, owing to replacing waterwheels. Madison No. 2 was strong the first half, increasing to the middle of the year, then declining. Black Eagle was weak the first part, but gradually increased the last half. The load on Billings was relatively uniform, whereas power was on and off at Big Hole. Holter was strongest the first month, then was off five months and fairly strong the rest of the year.

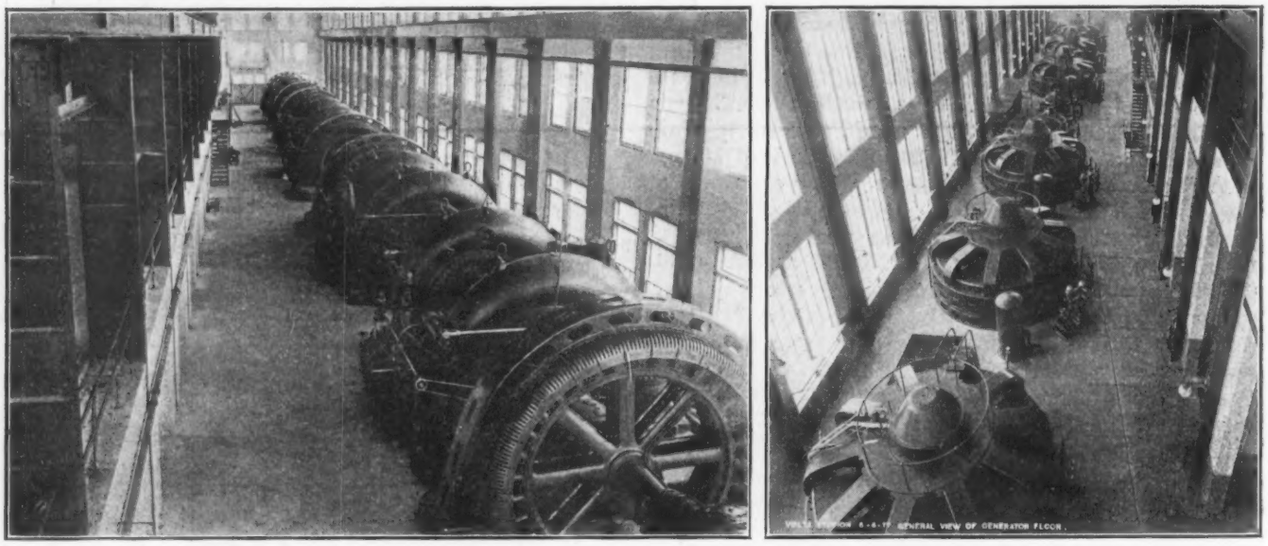
and the 100-kv. bus is on the second mezzanine. On the roof are lightning arresters, air-break disconnecting switches and line-tie switches.

Aside from its features of design, the plant is novel in that it lies between the centers of industrial load and has enough storage and generator capacity to carry any peak loads that may fall on any section of the system. With Canyon Ferry and Hauser Lake just above, it has 169,000 acre-ft. (207,000,000 cu.m.) of water immediately available, which would enable it to carry full load for a remarkably long time (see Table III).

This plant cost about $4,000,000, divided as shown in the accompanying circle diagrams (Figs. 5, 6 and 7). This cost refers to prices before 1918, when the plant was started. Two years and four months were required to complete the plant. If the cost of the transmission lines and reservoir and their share of the expense to develop a market are included, the cost per kilowatt installed would be nearer what a company just starting

524,000 acre-ft. (536,000,000 cu.m.). One acre-foot (1,230 cu.m.) of water will produce a flow of 1 sec.-ft. (0.028 cu.m. per second) for twelve hours. This storage is sufficient, therefore, to increase the flow of the Missouri River at Great Falls by 2,000 sec.-ft. (56 cu.m. per second) for a period of 132 days, or nearly four and one-half months.

Before these storage reservoirs were built the minimum flow of the Missouri River at Great Falls was about 2,200 sec.-ft. (61 cu.m. per second). With the storage reservoirs in operation the minimum has been increased to virtually 4,500 sec.-ft. (126 cu.m. per second). At the various plants on the Missouri and Madison Rivers above Great Falls the amount of available storage is somewhat less, but the natural flow of the rivers also is somewhat less, so that approximately the same ratio holds as regards the increased flow made available by storage. In other words, the minimum flow of the river, and hence the continuous power available,



OLD AND NEW PRACTICE OF THE MONTANA COMPANY IN THE GENERATOR ROOM

business would have to figure on under the same conditions.

Rainbow Falls is third in rating (35,000 kw.). It contains six horizontal 4,200-kw., 6,600-volt waterwheel-driven generators and two 5,000-kw. units. This represents the older practice of the company—from 1910 to 1916.

Thompson Falls is the fourth largest plant (30,000 kw.) and contains six vertical 5,000-kw., 6,600-volt waterwheel-driven generators. It is on the Clark Fork of the Columbia River and has the largest average river flow—15,809 cu.ft. (442 cu.m.) per second—available. The plant is not connected with the rest of the Montana system except through the Chicago, Milwaukee & St. Paul Railway 110,000-volt bus, through which line some energy is being transferred to supplement the other stations in the system.

The remaining plants were built before 1914.

By referring to Table III it will be noted that four of the plants listed have large storage reservoirs, and these are all on the Missouri River and its tributary the Madison River. The total storage represented on this river system is 199,000 acre-ft. (244,000,000 cu.m.) at the various power plants and 325,000 acre-ft. (399,000,000 cu.m.) more at the Hebgen reservoir, making a total of

has been practically doubled by the construction of the Hebgen reservoir and the several storage reservoirs at the various plants on the Madison and Missouri Rivers.

The amount of river regulation made possible is perhaps the most noteworthy feature of the Montana Power Company's system, doubling as it does the power which otherwise would have been available and doing away entirely with the necessity of any steam auxiliary power.

The great advantage of having the principal plants of the system on the same river is very apparent on account of the fact that each unit of storage is not only available for the plant at which the storage pond is formed but also for all the plants down river from the plant in question. Thus, as the system of rivers increased in natural flow from source to mouth, so with the series of plants developed on the system, the available storage increases also in approximately the same proportion.

With a system of this kind the plants are connected in series on the hydraulic end and in parallel on the electrical end. This means that in order to use the available water with the greatest economy loads are adjusted on the several plants on the system in such a way that the load on each plant is just sufficient to use a quantity of water which, passed on to each of the succeeding

TABLE IV—DATA REGARDING PRINCIPAL MONTANA TRANSMISSION LINES*

Route	Size of Wire	No. of Circuits	Miles
100,000-Volt Lines:			
Great Falls (g) to Rainbow (g) and Zinc Plant	4/0	1	4
Great Falls (g) to Morel (r) and Anaconda via Holter (r)	4/0	1	143
Branch to Gold Creek (r)	2/0	1	15
Great Falls (g) to Two Dot (r) and Harlowton (j)	115,000 circ.mil	1	114
Ranbow (g) to Great Falls—Morel line	circ.mil	1	4
Rainbow (g) to Butte (j) via East Helena (j)	1/0	2	125
Butte (j) to Anaconda	1/0	1	23
Holter (g) to East Helena (j)	115,000 circ.mil	1	31
East Helena (j) to Josephine (r) via Townsend (j)	115,000 circ.mil	1	55
Madison Nos. 1 and 2 (g) to Butte (j) via Piedmont (r) and Janney (r)	1/0	1	62
Thompson Falls (g) to East Portal (r) and Coeur d'Alene	7 No. 9 & 2/0	2	23
65,000-Volt Lines:			
Hauser Lake (g) and Canyon Ferry (g) to Butte (j) via Boulder (j)	105,000 circ.mil	2	68
Boulder (j) to Townsend (j)	4	1	36
Butte to Deer Lodge	4	1	16
50,000-Volt Lines:			
Rainbow (g) to Conrad	3 & 3 No. 9 G. I.	1	94
Rainbow (g) to Havre		1	104
Rainbow (g) to Harlowtown (j) via Lewiston (g)	3	1	168
Harlowton (j) to Carpenter Creek, via Lavina (j)	1	1	...
Billings (g) to Lavina (j)	1	1	...
Billings (g) to Livingston (g) via Park City (j)	3	1	112
Park City (j) to Bridges	3	1	...
Livingston (g) to Madison No. 2 via Hot Springs (j)	3	1	73
Madison Nos. 1 and 2 (g) to Three Forks (j)	3	1	29
Madison Nos. 1 and 2 (g) to Twin Bridges	4	1	49
Thompson Falls (g) to Plains	3	1	...

* (g) Means generating station. (j) Junction. (r) Railroad substation.

plants below on the river, will produce in the aggregate the total amount of power required from the system. If the natural flow at any time is greater than that required by the power demand on the system, it is stored and saved until such time as the power demand calls for water in excess of the natural flow. At times when the system is fully loaded considerable care is exercised by the load dispatcher in the manipulation of the rivers so that every second-foot is fully utilized and no water at any plant spilled over the dam.

A time interval of about seven days is required for water released from storage at the Hebgen dam to reach the furthermost plant of the system at Great Falls. If an unlooked-for increase in load occurs, this is taken care of immediately by the necessary draft of water from the local reservoirs at each plant. At the same time, however, the required additional amount of water is released from the Hebgen dam, and during the following week as this increased flow reaches the various plants in succession the amount of water which was temporarily taken from the local reservoirs is replaced so that the head at each plant is maintained at nearly its maximum point. Although this continual adjustment and manipulation of the rivers requires some little skill, yet it has been found by experience that very little difficulty is encountered in making the necessary adjustments for the maximum efficiency of operation of the system as a whole.

TABLE V—GENERAL STATISTICS

	1919	1918
Generator rating (kw.)	212,340	200,855
Maximum load (kw.)	152,800	162,900
Average load (kw.)	98,858	126,498
Energy generated (kw.-hr.)	863,960,624	1,106,663,860
Load factor (yearly)	65	74
Load factor (average monthly)	77	82
Connected load (hp.)	315,909	304,541
Loss in transmission and distribution	17	14
Consumption (kw.-hr.)	720,681,439	951,901,714
Number customers served*	44,505	.....
Area of territory, miles	260x300	.....
Miles of transmission line	1,922	.....
Miles of power wire	6,031	.....
Miles of distribution wire	4,113	.....

* Excluding large mines, smelters, refineries and railroads.

The tying together of the plants electrically and the possibility of perfectly free interchange of power without the usual prejudice or bias which exists where interconnection is made between different companies makes it possible to utilize to the greatest extent possible all such plants as naturally would be unable to maintain a continuous or reliable supply of power. Some of the older and smaller plants of the system, such as those at Big Hole, Livingston and Billings, are subject to extremely low water during certain periods of the year, so that their output is reduced to less than 25 per cent of their rated capacity. Such plants if operated singly would be of virtually no value whatever in carrying a commercial load. Tied in with the rest of the system, however, they can be operated all the year round so as to use all water available, and the kilowatt-hours they furnish are just as valuable as if they were furnished 365 days in the year. Practically speaking, their interconnection electrically with the other and larger plants is equivalent to supplying them with their share of the storage which is available at the other plants.

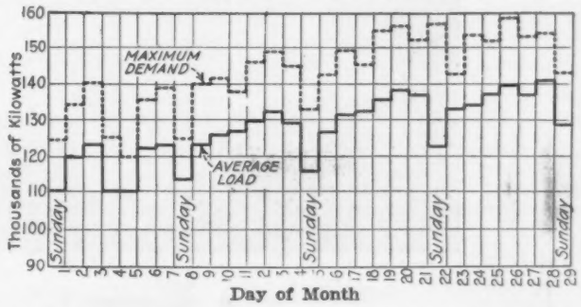


FIG. 3—AVERAGE AND MAXIMUM DEMANDS BY DAYS FOR FEBRUARY, 1920

Note the high load factor, marked decreases on Sunday, nonuniformity of weekly load but general increase.

To sum the matter up, it can be said that the series hydraulic connection and the parallel electrical connection of the plants in Montana, together with the storage which has been made available, have made the effective capacity of the system as a whole at least twice what it would be if the various units of the system were separate and independent.

With the present system as a nucleus, the Montana Power Company is now very advantageously situated as regards the development of additional water-power sites. In the case of a single water-power development built to carry a certain load, the plant must be developed for the anticipated load factor of the load in question, regardless of the natural advantages or disadvantages of the site. With a system such as that of the Montana Power Company to tie into, a new development can be made to operate at any load factor that may be considered desirable; for example, a high-head plant involving the use of a long pipe line, where the pipe line represents the larger percentage of the investment, would naturally be developed to operate at a high load factor so that the pipe line would be operated at its full capacity continuously and the greatest number of kilowatt-hours during the year obtained from a given investment. On the other hand, a low-head or medium-head plant, in which the head is developed by means of a dam and short penstocks, would naturally be developed for a comparatively low load factor so that the storage made available by the dam could be utilized to carry peak loads and the ad-

Some Undeveloped Water Powers in Montana

A—Mystic Lake, which will probably be used to furnish 26,000 acre-ft. of storage for an 1,100-ft. head development of 10,000 kw. B—The falls below the lake, which will furnish part of the head. C and D—Three falls in Snake River which would furnish a natural head for a 22,500-kw. development. E—Site on the Madison River where 13,500 kw. can be developed. F—Point on Missouri River below Great Falls where dam can be built to impound water for 28,500-kw. development; a 60-ft. dam 1,000 ft. long would be required for such a rating.

ditional investment required for this peak load capacity would be only that represented by additional generators and waterwheels.

One thing that has to be taken into consideration in utilizing the reservoirs is the time required for the water released to reach stations downstream. For instance, the Hebgen reservoir is 300 miles (480 km.) above Rainbow, so it requires seven days for water to travel between the two places. Likewise, Holter is five days (water travel) from Hebgen. However, the storage immediately available above this plant, Hauser Lake and Canyon Ferry, is sufficient to carry full load on each plant until water from the Hebgen reservoir reaches them. Hence peak loads can be thrown onto these three plants simultaneously.

As indicated by the map, page 1056, and Table VI, the generating stations are so located and the transmission system so laid out that the centers of industrial load—Butte, Anaconda, Helena and Great Falls—have several sources of energy as well as several channels through which to receive it.

For instance, Anaconda can receive energy over the Great Falls-Anaconda line, the two Rainbow-Anaconda lines or the two lines from Hauser Lake and Canyon Ferry to Butte. Butte, in turn, can be served from the same lines. Some help may also be received in the Butte and Anaconda districts from Big Hole and Madison Nos. 1 and 2. Helena district is fed from Holter, Canyon Ferry, Rainbow Falls and indirectly from Great Falls. Great Falls district is immediately in the vicinity of Rainbow Falls, Great Falls and Black Eagle and may also be fed from Holter as well as other plants connected to the system. Holter, being situated between the big load centers, can transmit energy to them very economically when the nearby plants become overloaded and, besides, is well equipped to take peak loads, as mentioned before. The value of interconnection has been particularly appreciated in the Butte-Anaconda district, where, owing to the several sources of energy and the various lines over which it can be transmitted and the fact that they run over different routes and are not likely to be affected by disturbances simultaneously, there is practically no opportunity for any load center to be without energy. In fact, the mines, which have to consider reliability of service more than any other users, perhaps, have not because of past experience deemed it necessary to have any standby generating equipment.

CONTINUITY OF SERVICE ASSURED BY NETWORK

Because the many transmission lines mentioned tap a 100,000-volt bus line along the Chicago, Milwaukee & St. Paul Railway at seven points, the Montana Power Company is able to give the railroad absolutely reliable service. Several of these tie-in points can be fed from more than one transmission line. For instance, Two Dot can receive energy from Great Falls directly or Rainbow and other plants indirectly; Josephine can be fed from East Helena, which is a junction point for several main transmission lines; Piedmont and Janney tap a main line between Madison Nos. 1 and 2 and Butte and hence can receive energy from two directions and several stations; Morel is fed directly by Great Falls and Holter over one line and may be connected with other plants over this and another line; Gold Creek also taps a main line that can be fed from two directions; East Portal receives energy over duplicate lines from Thompson Falls. The 100,000-volt bus line affords still another channel for transfer of energy.

During the war the policy of the Montana Power Company was to postpone all except absolutely necessary construction (Holter, as mentioned before, was built during the war). No large construction work was done during 1919 either. The principal addition was a line from Harlowton to Roundup and Carpenter Creek coal district and a tie line from this line to Billings.

As may be observed from Fig. 1, showing the monthly peak loads, average loads and station capacity, there was a slight slump in business immediately after the beginning of the war and another severe decline in business in the last half of 1917, due to a mine strike. The signing of the armistice and the simultaneous drop in the

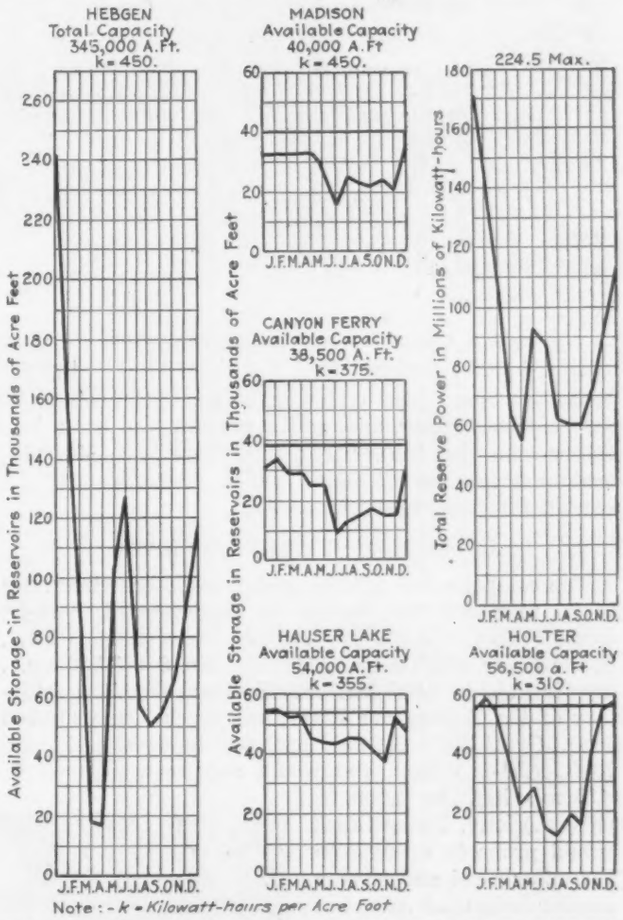


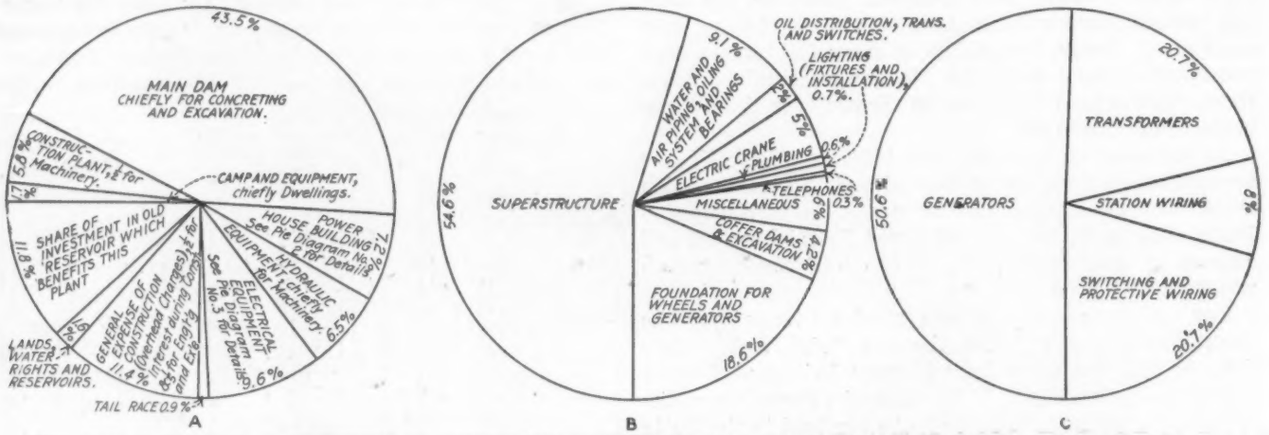
FIG. 4—AMOUNTS OF STORAGE AVAILABLE IN HEBGEN, MADISON, CANYON FERRY, HAUSER LAKE AND HOLTER RESERVOIRS AT DIFFERENT PERIODS OF 1919, THE DRIEST YEAR IN A CONSIDERABLE PERIOD, WITH TOTAL EQUIVALENT ENERGY IN RESERVE

copper market had a very marked effect, but the load is now increasing at a greater rate than before.

The loads are now about what they were in 1918, the average and maximum demands for February, 1920, being shown in Fig. 3. As will be noted, the load factor is very high. There is no uniformity in the weekly load curves except for the Sunday decline and the general increase in load. Copper and zinc mines and reduction plants have increased operations, silver mining has revived, and ferromanganese has shown special activity. Besides the natural rate of growth in established Montana industries, the development of new industries which will use large amounts of electrical energy, such as electric steel and brass production, is looked for. Owing to the high cost of harvesting natural ice there

has been quite a boom in artificial ice production by electricity. Several opportunities to electrify railroads still remain. The Northern Pacific and the Great Northern provide the most favorable opportunities and are now considering electrification, while the Chicago, Burlington & Quincy and the Oregon Short Line also operate the state.

It is probable that the existing system will be able to handle the normal increase in load for one or two years to come. The system is designed for about 70 per cent load factor, and, as the present load has a load factor somewhat higher than this, there is considerable peak-load capacity available, which is particularly desirable for railroad electrification.


43.5%
MAIN DAM CHIEFLY FOR CONCRETING AND EXCAVATION.
CONSTRUCTION PLANT, for Machinery.
CAMP AND EQUIPMENT, chiefly Dwellings.
SHARE OF INVESTMENT IN OLD RESERVOIR WHICH BENEFITS THIS PLANT
POWER HOUSE BUILDING See Pie Diagram No. 2 for Details
HYDRAULIC EQUIPMENT, chiefly for Machinery
ELECTRICAL EQUIPMENT See Pie Diagram No. 3 for Details
GENERAL EXPENSE OF CONSTRUCTION (Overhead Charges), Interest during Construction, and Taxes
LANDS, WATER-RIGHTS AND RESERVOIRS.
TAIL RACE 0.9%
A
OIL DISTRIBUTION, TRANS. AND SWITCHES.
WATER AND AIR PIPING SYSTEM AND OILING BEARINGS
LIGHTING (FIXTURES AND INSTALLATION) 0.7%
ELECTRIC CRANE
PLUMBING
TELEPHONES
MISCELLANEOUS
COFFER DAMS & EXCAVATION
SUPERSTRUCTURE
FOUNDATION FOR WHEELS AND GENERATORS
B
TRANSFORMERS
GENERATORS
STATION WIRING
SWITCHING AND PROTECTIVE WIRING
C

FIGS. 5, 6 AND 7—DISTRIBUTION OF INVESTMENT IN THE MONTANA POWER COMPANY'S LATEST PLANT, HOLTER
A—Major classification of 40,000-kw. plant. B—Itemization of investment in power house. C—Electrical equipment.

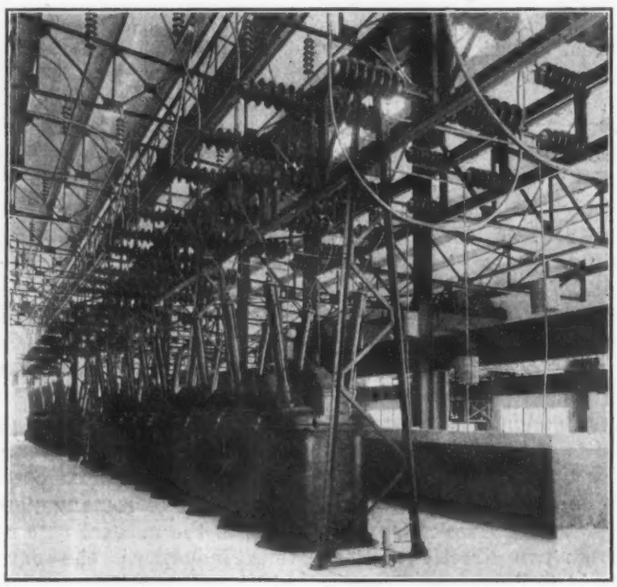
UNDEVELOPED WATER-POWER SITES

The company has several desirable water-power sites in its territory that remain to be developed, namely, Great Falls C (28,500 kw.), Sheep Creek (28,500 kw.), Snake River (22,500 kw.), Madison No. 3 (13,500 kw.), Mystic Lake (10,000 kw.), on Rosebud Creek, a tributary of the Yellowstone River, and Black Eagle (10,000 kw.). Great Falls C would probably be developed for a 70-ft. (2.1-m.) head and would require a dam 60 ft. (18 m.) high by 1,000 ft. (300 m.) long. Sheep Creek would probably operate on a similar head and have a similar length of dam, but it would not have to be higher than 45 ft. (13.5 m.).

Mystic Lake, with an 1,100-ft. (330-m.) natural head available and 26,000 acre-ft. (32,000,000 cu.m.) of storage, is the most promising site in the eastern part of the State and will in all probability be the next to be developed. A 15-ft. (4.5-m.) dam and about 2 miles (3.2 km.) of penstock will be required. Black Eagle will probably be developed for a 42-ft. (12.6-m.) head by utilizing a 24-ft. (7.2-m) dam about 750 ft. (225 m.) long already built, impounding about 700 acre-ft. (860,000 cu.m.). After developing Mystic Lake, the Montana Power Company will next consider the sites around Great Falls, namely, Black Eagle, Great Falls C and Sheep Creek. Most of these power sites are shown on page 1048 and on the map, page 1056.

As in the past, the policy will be followed of so laying out future transmission lines that service shall be available to almost any industry that may be established in the State, that as many towns as possible may be reached, the most reliable service provided and development of water-power sites facilitated.

For example, if the Great Northern electrifies, a line might be built along the right-of-way from Havre at the east end to the state line on the west and fed at Havre, Cut Bank, Whitefish and Troy. Havre could be served from all existing plants through the present line to Havre, after being reinforced. Cut Bank and Whitefish could be served by lines from Thompson Falls. Mystic Lake would in all likelihood be connected with the Bozeman-Billings line, reinforcing that system, which runs along the Northern Pacific Railway. The transmission lines from Thompson Falls to the Cœur d'Alene mining district run very close to lines of the Washington Water Power Company, but there is no immediate need of interconnection. All of these interconnections will depend on conditions making them economically possible not only as to investment but as to operating expense. In general it costs about 15 cents per kilowatt-year per mile to transmit energy, which is a rough basis on which it is possible to make a rough determination as to whether it is better to utilize local energy or transmit it from a distance.



SWITCHING EQUIPMENT IN THE MOST MODERN STATION, HOLTER

The foregoing information has been obtained with the courteous co-operation of John D. Ryan, president of the Montana Power Company; F. M. Kerr, vice-president and general manager; H. H. Cochrane, chief engineer, and others.

Giving Service in Agricultural Districts

Sparsely Settled Communities That Would Ordinarily Be Considered Uneconomical to Serve Are Being Fed by the Washington Water Power Company, Which Also Serves Two Other Systems and an Electrified Railroad

INCREASED economy, production, convenience and comfort made possible by electric service are evident everywhere, but these benefits are particularly marked where the large cities are widely separated and the towns sparsely settled and far from sources of fuel. This is particularly true in that section of the State of Washington east of the Big Bend in the Columbia River which is served by the Washington Water Power Company. There industry, as usually understood in most parts of the country, is not so predominant as agricultural pursuits, which are naturally spread over greater expanses of territory and are therefore more dependent on electric service from a large interconnected system because the carrying charges on fuel make its price almost prohibitive. In that section electricity has been made available at a moderate price through an abundant natural resource—water power—and water storage and interconnection of various plants make it possible to give a more reliable and economical service than could be furnished by individual plants. Furthermore, the service can be rendered without any steam reserve, which would add considerably to the cost of service.

LONG LAKE DAM AND 46,700-KW. PLANT OF WASHINGTON WATER POWER COMPANY AT LOWER END OF LONG LAKE. THIS IS THE NEWEST AND LARGEST OF ITS FOUR STATIONS

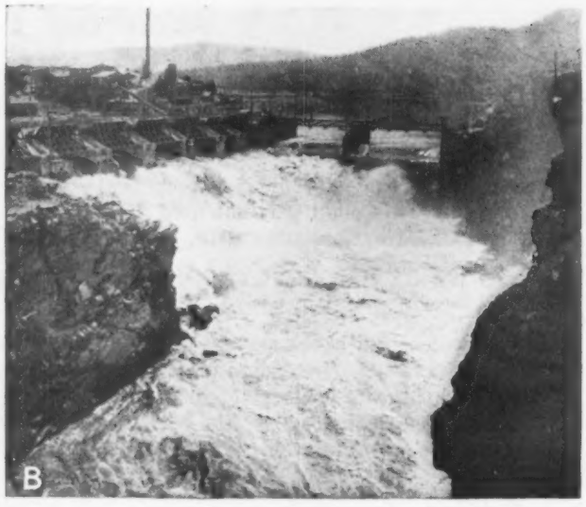
Development of the System

As shown by the map on page 1056 the lines of the Washington Water Power Company now cover a territory about 100 miles (160 km.) in both directions, east and west, and a like distance north and south, but this system started from a nucleus centered in Spokane and grew by gradually extending lines to markets in the neighborhood which would justify the investment and losses in transmission lines. The initial hydro-electric station was situated at Spokane on the Spokane River (see Table I and Fig. 1). As the load further increased another hydro-electric plant was erected upstream in 1906 near Lake Cœur d'Alene, with its enormous storage area of 45 sq. miles (116 sq. km.). Because of slack flow in the river at certain periods of the year it was necessary to build a steam reserve plant at Spokane in 1907 to supplement the existing hydro-electric plants, but more especially to supply energy during the interval before the development of more water power. Meanwhile the transmission system had been extended and the benefits of electric service had become so generally recognized that it was necessary to provide additional generating capacity at Little Falls on the Spokane River. Finally Long Lake development, with its wonderful storage of 62,000 acre-ft. (76,260,000 cu.-m.), exceeded only by Lake Cœur d'Alene, was completed in 1915. Since all the hydro-electric plants were interconnected and had sufficient storage to regulate the river flow, it was possible after Long Lake was placed in operation to shut down and dismantle the old steam plant at Spokane, which had formerly been required only to compensate for slack flow anyway. This plant was not used much after 1910 and not at all after January, 1912.

Factors Which Had to Be Considered in Extending Lines

Simultaneously with the development of new water-power sites came the extension of transmission lines, first to nearby towns such as Medical Lake, southwest of Spokane; subsequently to the Cœur d'Alene lead and silver mining district in northern Idaho; north of Post Falls to the lumber district; the Palouse territory to the south, with similar agricultural pursuits, and the Big Bend country, a rich fruit-growing and wheat-raising district to the southwest of Spokane. These sections now rank in about the preceding order as far as load centers are concerned. In extending lines to each of these sections consideration had to be given to the immediate or likely revenue which could be obtained and the possibility of its paying a reasonable return on the expense of rendering the service. Sometimes a definite enough load could be seen to justify the extension; at other times sufficient revenue to warrant the extension had to be assured by the concern or community which desired service. In some instances where the transmission company could not afford to extend a line the communities or concerns desiring power wanted it sufficiently to build a line up to the Washington Water Power Company's system. In still other cases farmers who desired service and could not be served otherwise have banded together, guaranteed a satisfactory yearly revenue and have also financed part of the line. Furthermore, the farmers agree to use power for a long enough period to make the revenue at least equal the investment in the extension. Of course, after

Hydro-Electric Plants in Eastern Washington



A—Undeveloped power about 2,050 ft. above Spokane plant which is soon to be utilized. B—Control works of Post Falls plant. C—Forebay, spillway and power house of Little Falls plant. D—Largest and newest plant at Long Lake during flood stage. E—Bend in Spokane River below Long Lake at site of Long Lake plant before construction.

they have once tasted the benefits of electric service there is not much likelihood of their discontinuing it. Much of the farm and municipal pumping load is served on the flat-rate basis, but other loads are connected on the maximum-demand and energy-charge basis.

Where the power company sees an opportunity to serve several communities it finances its own trunk lines and requires the small communities only to contribute to the financing of the laterals necessary to serve

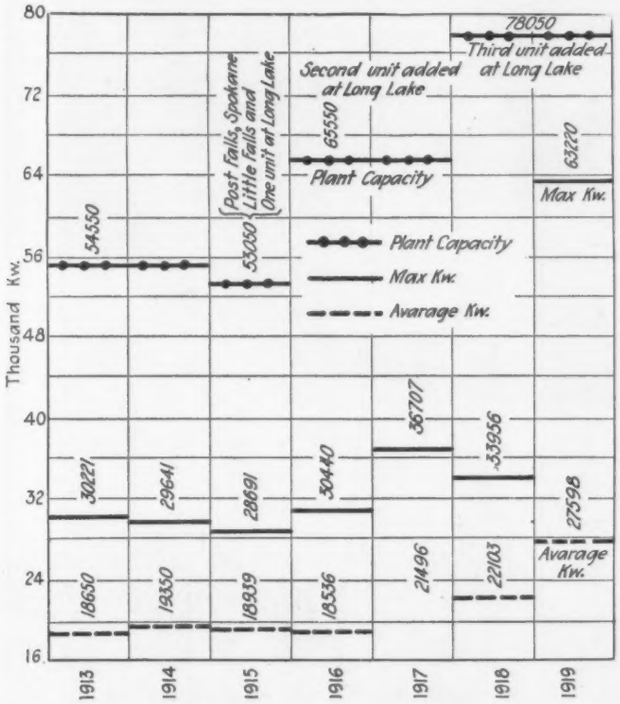


FIG. 1—PEAK LOAD, AVERAGE LOAD AND GENERATING CAPACITY OF WASHINGTON WATER POWER COMPANY FOR PAST SEVERAL YEARS

them in the manner previously described. Sometimes these trunk lines have to be built of steel wire with long spans to avoid a non-paying investment. As the loads develop, however, and the trunk lines are extended they may be converted from second-rate or third-rate construction to first class or second class to reduce the transmission losses and make them more suitable as trunk lines. Some of the lines are steel or copper-clad steel; others, of the first-class trunk-line type, are of aluminum or copper. Rural service is given only from

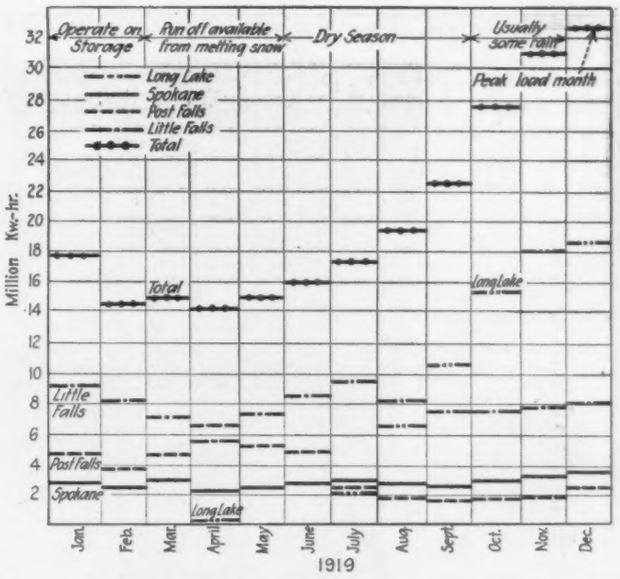


FIG. 2—AVERAGE MONTHLY LOADS FOR 1919 AND DISTRIBUTION OF LOAD BETWEEN PLANTS

The yearly average load for Little Falls was 10,725 kw.; for Long Lake, 8,110 kw.; for Post Falls, 4,840 kw., and for Spokane, 3,925 kw.

13,000-volt lines or lines operating at a lower voltage because the expense of stepping down the voltage from the 60,000-volt and 22,000-volt lines is too great to justify serving small loads from them. Where sufficient small loads develop along 60,000-volt or 22,000-volt lines that are now traversing sparsely settled territory it is possible that relatively large step-down substations may be provided at some points to feed lower-voltage bus lines from which these communities may be served. However, such a departure from present practice can come only if the total load which can be served from each bus line will warrant the expense.

Still further benefits from electric service are resulting from interconnection in the larger sense—that is between systems—since through these lines energy can be transferred from one company when it has a surplus of power to another during its peak-load period. So far the system interconnections which have been made are only for transferring energy one way, but nevertheless the tie lines may be used later for the purpose of exchange which will benefit the companies at both ends. For example, the Washington Water Power Company is now delivering energy from its Long Lake plant to the Pacific Power & Light Company at Lind (see map)

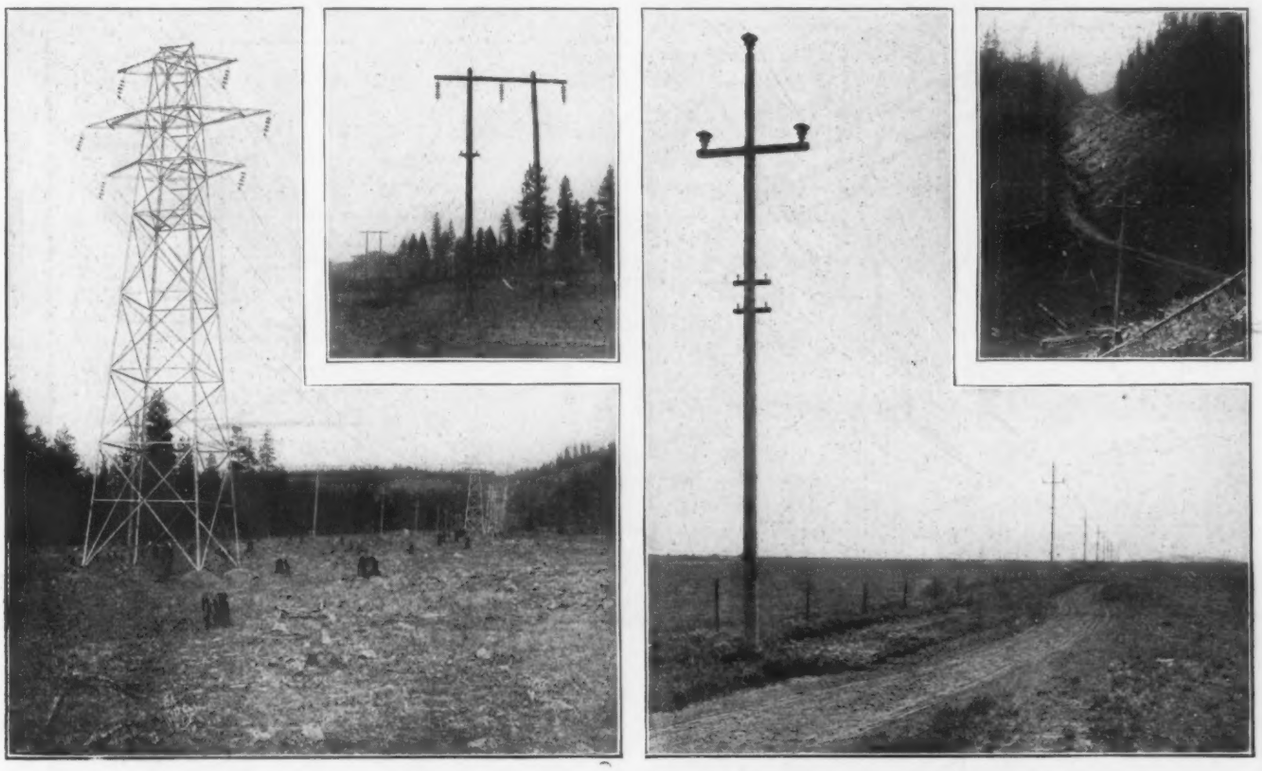
TABLE I—ENGINEERING AND OPERATING CHARACTERISTICS OF THE HYDRO-ELECTRIC PLANTS FOR 1919

Position on Stream	Name of Plant and Location	Year Completed	Rating (Kw.)	Average Head (Ft.)	Storage (Acre-Ft.)	Dam Height Ft.	Dam Length (Ft.)	Water Flow Sec.-ft. Max.	Water Flow Sec.-ft. Min.	Water Flow Sec.-ft. Average	Kw. Per Sec.-Foot	Load Factor, Per Cent. Yearly
(5)	Long Lake on Long Lake....	1915	46,700	168	62,000[5]	248	251 + 102	50,000	2,065	3,250[7]	12.0	37.4
(4)	Little Falls, Spokane River..	1910	22,800	73[1]	1,740[6]	64	600	50,000	2,065	3,250[7]	5.0	45.8
(1)	Post Falls, Spokane River...	1906	1,250	50–56[1]	161,150[8]	52[8] 64[8] 45[8]	431 180 78	40,000	840	1,735[7]	3.5	42.4
(2)	Spokane, Spokane River.....	....	8,800	75[2]	158,400[6]	19–26	360 + 90	40,000	1,300	2,500	4.0	61.9

1 At low water.
2 Can be increased to 144 ft. by taking water 2,000 ft. further upstream.
3 At 15-ft. draw-down.
4 At 10-ft. draw-down.
5 Water storage in Lake Coeur d'Alene, 158,400 acre-ft.; forebay, 2,750 acre-ft.
6 Water storage in Lake Coeur d'Alene, immediate storage sufficient only for daily variation in loads.
7 For four months in summer.
8 Three channels with the power plant at the middle one.
9 With full load on each unit.

Swan Falls Development of Idaho Power Company on Snake River, Having Rating of 9,900 Kw.

over the Intermountain Power Company line, and through this line and the Chicago, Milwaukee & St. Paul bus line is delivering energy to the Puget Sound Traction, Railway & Light Company on the extreme western side of the State. Reciprocally, if either of these companies overdevelops its system, it can return energy to the Washington Water Power Company. This has not been nor is it now essential because the Washington Water Power Company has been overdeveloped since the beginning of the European war and has had more energy than it could sell in its own territory. However, its business is fast growing and the time may come when its load will exceed what it can furnish from its existing plants. Then exchange of energy will be valuable. As a result of such exchange each of the interconnected companies can get along with less reserve generating equipment.



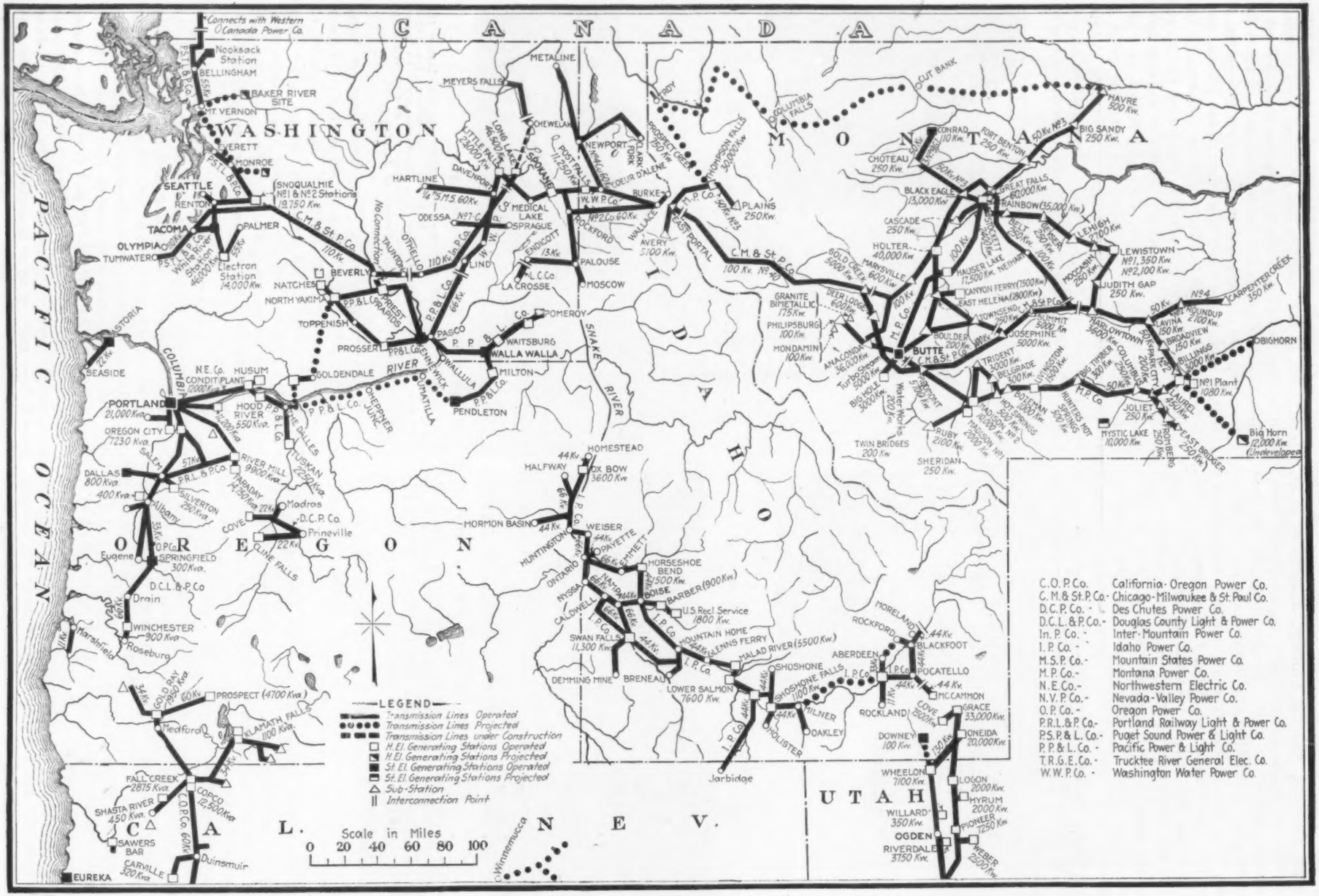
SOME MAJOR TRUNK LINES AND CIRCUITS TO LOAD CENTERS IN EASTERN WASHINGTON

On left, double-circuit 60,000-volt line connecting Little Falls and Long Lake with Spokane, the hub of the Washington Water Power System. In insert on left, single-circuit 110,000-volt line of Intermountain Power Company from Long Lake to Lind and Taunton, feeding the Pacific Power & Light Company, Chicago, Milwaukee & St. Paul Railway, and through the latter the Puget Sound Traction, Light & Power Company. On right, wood-pole 60,000-volt line feeding Big Bend country. In insert on right, Cœur d'Alene 60,000-volt transmission line of Washington Water Power Company in Fourth of July Canyon.

How Water Is Utilized to Best Advantage

The interconnection of plants that exists within the Washington Water Power Company's system enables it to give the most reliable type of service and at the same time to utilize the flow in the Spokane River and the storage in Lake Cœur d'Alene and Long Lake to the best advantage. In general during low-water season it is the practice so to operate the plants that all water is utilized. Post Falls plant, which is farthest upstream on the Spokane River of all of the four plants and consequently nearest Lake Cœur d'Alene, is operated at a uniform load which will maintain the minimum flow required in the Spokane River. This flow is sufficient to operate the plant at Spokane at near its normal generator rating. Long Lake plant, which is the next plant downstream and immediately at the outlet from Long Lake, in turn carries just sufficient load to maintain a flow at Little Falls to operate this plant at a rating that will carry the remaining load. This is the reason why the oldest plant on the system is operated at a higher load factor than the other three plants, contrary to the practice which would be followed if the stations were all steam plants. If the water discharged from Lake Cœur d'Alene raises the water at Long Lake so that there is a chance of its being spilled over the dam, then the load is redistributed and all the water is utilized. Because of the fact that it is desired to keep as much water in storage at Lake Cœur d'Alene as possible during low-water seasons, peak loads are taken by Long Lake or Little Falls. The draw-down on Long Lake during such periods is regained during light loads by collecting water from upstream. Since operation of the plants to secure the maximum use of water does not always give the best power factor and voltage regulation if uncompensated, the idle generators in each plant are used during low water for power-factor correction.

During flood season the plants are operated to insure the best voltage regulation and power factor and the least transmision loss regardless of whether the water is utilized to the best extent or not. At such times water is usually running over the spillways at each plant. During October and November enough rain usually falls to regain most of the storage "let go" during the summer, and thus ample water is available for the annual peak load, which occurs in December. From March to June run-off from melting snow is expected so that water can be stored for the dry season. The system load factor is

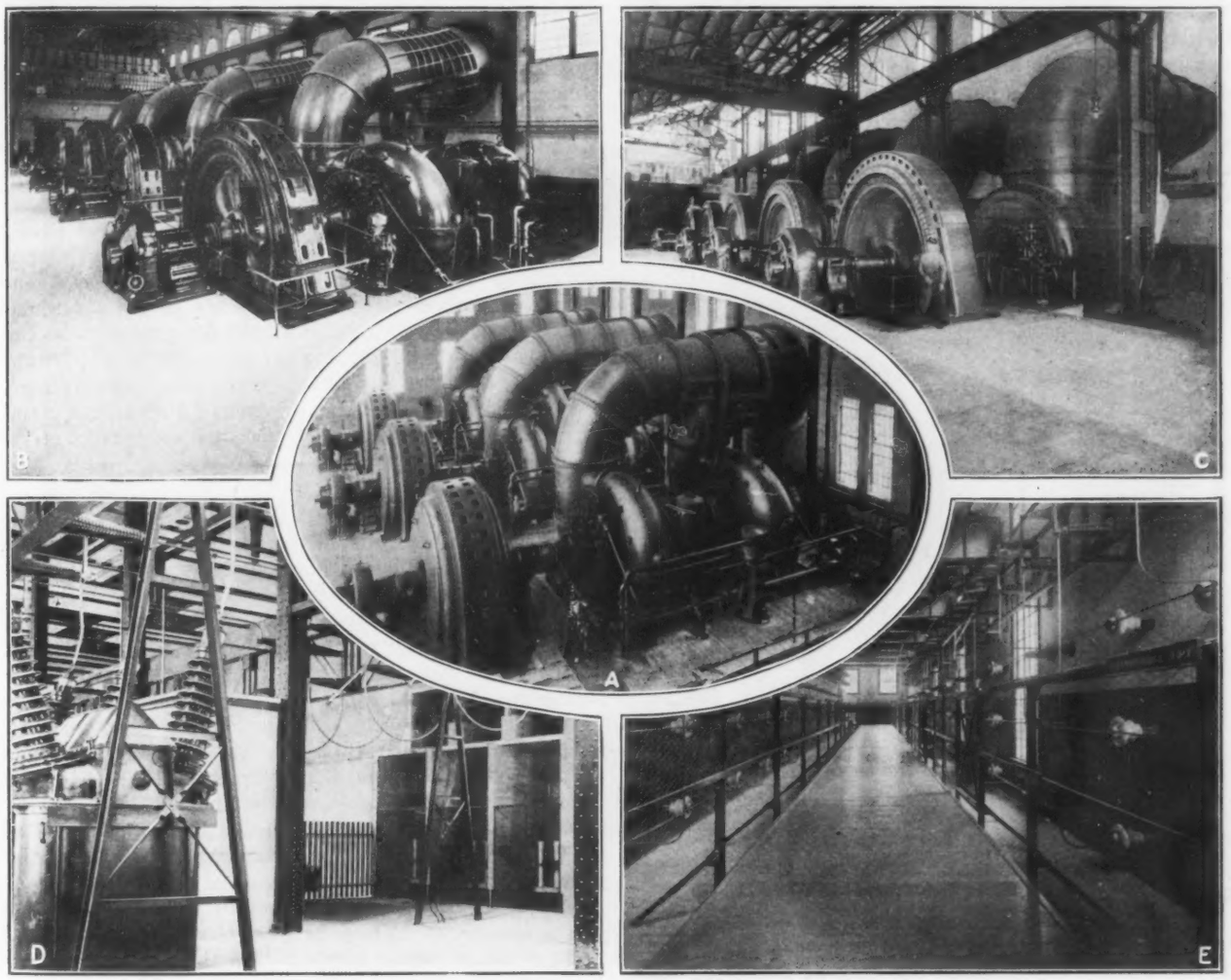

CANADA
WASHINGTON
OREGON
IDAHO
MONTANA
NEV.
UTAH
CALIF.
PACIFIC OCEAN
Connects with Western Canada Power Co.
Nooksack Station
BELLINGHAM
BAKER RIVER SITE
ST. VERNON
EVERETT
MONROE
SEATTLE
RENTON
SNOQUALMIE No1 & No2 Stations 19,750 Kw.
TACOMA
PALMER
OLYMPIA
TUMWATER
White River Station 46,000 Kw.
Electron Station 14,000 Kw.
C.M. & St. P. Co.
110 Kv.
55 Kv.
BEVERLY
NATCHES
NORTH YAKIMA
TOPPENISH
PROSSER
GOLDENDALE
PRIEST RAPIDS
No Connection
TAUNTON
OTHELLO
PASCO
P.P.&L. Co.
68 Kv.
P.P.&L. Co.
110 Kv.
LIND
WAITSBURG
WALLA WALLA
MILTON
PENDLETON
UMATILLA
WALLULA
KENNEWICK
PROSSER
P.P.&L. Co.
ONEPENNER JUNC.
SNAKE RIVER
COLUMBIA RIVER
ASTORIA
SEASIDE
PORTLAND
21,000 Kva.
OREGON CITY
7230 Kva.
N.E. Co. HUSUM CONDIT PLANT 12000 Kva.
HOOD RIVER
P.R.L. & P. Co.
200 Kva.
550 Kva.
THE DALLES
TUSKAN
2250 Kva.
RIVER MILL
9900 Kva.
FARADAY
14,250 Kva.
22 Kv.
Madras
D.C.P. Co.
Prineville
COVE
CLINE FALLS
SALEM
51 Kv.
P.R.L. & P. Co.
DALLAS
800 Kva.
400 Kva.
Albany
SILVERTON
250 Kva.
34 Kv.
O.P. Co.
Eugene
SPRINGFIELD
300 Kva.
D.C.L. & P. Co
Drain
66 Kv.
WINCHESTER
900 Kva.
Roseburg
17 Kv.
Marshfield
24 Kv.
GOLD RAY
1950 Kva.
60 Kv.
PROSPECT (4700 Kva.)
Medford
KLAMATH FALLS
1100 Kva.
34 Kv.
FALL CREEK
2875 Kva.
SHASTA RIVER
450 Kva.
COPCO
12,500 Kva.
C.O.P. Co. 60 Kv.
SAWERS BAR
CARVILLE
320 Kva.
Duinsmuir
EUREKA
METALINE
MEYERS FALLS
CHEWELAH
LONG LAKE
46,500 Kw.
LITTLE FALLS
23,000 Kw.
SPOKANE
POST FALLS
11,250 Kw.
NEWPORT
CLARK FORK
COEUR D'ALENE
PROSPECT CREEK
750 Kw.
THOMPSON FALLS
30,000 Kw.
HARTLINE
DAVENPORT
ODESSA No7 Co.
MEDICAL LAKE
SPRAGUE
ENDICOTT
LA CROSSE
PALOUSE
MOSCOW
W.W.P. Co.
No2 Co. 60 Kv.
ROCKFORD
BURKE
WALLACE
AVERY
5100 Kw.
EAST PORTAL
M.P. Co.
50 Kv. No3
PLAINS
250 Kw.
C.M. & St. P. Co.
100 Kv. No4
COLUMBIA FALLS
CUT BANK
HAVRE
500 Kw.
BIG SANDY
250 Kw.
50 Kv No3
CONRAD
110 Kw.
FORT BENTON
250 Kw.
CHOTEAU
250 Kw.
50 Kv No3
GREAT FALLS
82,000 Kw.
RAINBOW (35,000 Kw.)
BLACK EAGLE
13,000 Kw.
CASCADE
250 Kw.
HOLTER
40,000 Kw.
MARYSVILLE
600 Kw.
GOLD CREEK
5000 Kw.
DEER LODGE
600 Kw.
GRANITE BIMETALLIC
175 Kw.
PHILIPSBURG
100 Kw.
MONDAMIN
100 Kw.
ANACONDA
36,000 Kw.
Turbo-Steam
5000 Kw.
BIG HOLE
3000 Kw.
BUTTE
C.M. & St. P. Co.
M.P. Co.
100 Kv.
HAUSER LAKE
12,500 Kw.
NEIHART
CANYON FERRY (7500 Kw.)
EAST HELENA (2800 Kw.)
TOWNSEND
250 Kw.
BOULDER
200 Kw.
JOSEPHINE
5000 Kw.
SUMMIT
5000 Kw.
TRIDENT
3000 Kw.
BELGRADE
300 Kw.
WATER WORKS
200 Kw.
HOT SPRINGS
200 Kw.
HUNTERS HOT SPRINGS
400 Kw.
TWIN BRIDGES
200 Kw.
RUBY
2100 Kw.
SHERIDAN
250 Kw.
MYSTIC LAKE
11,000 Kw.
JOLIET
250 Kw.
BIG TIMBER
300 Kw.
50 Kv
BOTHMAN
1200 Kw.
M.P. Co.
50 Kv
COLUMBUS
250 Kw.
50 Kv
FRANK CITY
200 Kw.
50 Kv
ROMBERG
250 Kw.
50 Kv
LAUREL
250 Kw.
EAST BRIDGER
250 Kw.
No1 Plant
1080 Kw.
Big Horn
12,000 Kw.
(Undeveloped)
BIGHORN
No4
CARPENTER CREEK
350 Kw.
No4
ROUNDUP
2100 Kw.
LAVINA
150 Kw.
BROADVIEW
150 Kw.
BILLINGS
3000 Kw.
50 Kv
LEWISTOWN
No1, 350 Kw.
No2, 100 Kw.
JUDITH GAP
250 Kw.
MOCCASIN
250 Kw.
100 Kv
LENHAM
2100 Kw.
BOTT
250 Kw.
100 Kv
SCOTT
100 Kv
HARLOWTOWN
3600 Kw.
50 Kv
50 Kv
50 Kv

increasing, and as this tendency increases it will be necessary to draw down on Long Lake during the dry season to a greater extent than at present.

VALUE OF STORAGE

The full benefits of storage in Lake Cœur d'Alene have not been utilized so far, as it was unnecessary to conserve all the water during the last few years since the construction of Long Lake station has provided an excess of power capacity up to the present time.

Storage is highly desirable on practically all Western rivers which have their source in the mountains as they are subject to wide variation in flow in successive months and years.



EQUIPMENT OF SOME OF THE WASHINGTON WATER POWER COMPANY'S HYDRO-ELECTRIC PLANTS

A—Three 13,900-kva. blower-cooled generators at the Long Lake station driven by double-runner waterwheels. B—Four similar but lower-head waterwheel-driven generators at Little Falls. C—Five double-runner waterwheel-driven generators at Post Falls. D—110,000-volt switch room at Long Lake with reactor compartments in background. E—Half of 60,000-volt bus room at next to newest station of the Washington Water Power Company at Little Falls.

FEATURES OF HYDRO-ELECTRIC PLANTS

The three latest hydro-electric plants have been described quite fully in former issues of the ELECTRICAL WORLD.* Some of the general features brought up to date are given in Table I and outlined below.

Post Falls plant, which is 10 miles (16 km.) below Lake Cœur d'Alene, is built across the middle of three channels at this point and the other channels are dammed. The south channel has six sliding gates with an ingenious traveling gate hoister. The north channel contains the principal control works, comprising seven Tainter gate sluiceways, one log sluice and a 110-ft. (33-m.) main sluiceway fitted with two bear-trap dams. During the spring, when high water prevails in the Tainter gates, bear traps and sluiceways are kept open.

Little Falls, the next plant to be completed, has a cyclopean concrete dam with two hand-operated relief gates of the inverse Tainter type which provide for low-water discharge. The spillway is 604 ft. (180 m.) long. The penstocks are closed by motor-operated headgates bearing on rollers. Four 5,500-kva. generators driven by horizontal twin-runner waterwheels are provided.

The Long Lake development, the most modern of the four plants, has a dam which is unique in at least two particulars. The water spills over the dam itself, making it one of the highest spillway dams in existence. At times of flood about 19 ft. (5.7 m.) of water flows over the crest. Six vertical-lift waste gates are mounted on the crest of the spillway to hold the low-water level at the same level as during high water. The total length of spillway through the gates is 150 ft. (45 m.).

Three generators driven by 22,500-hp. waterwheels,

*May 23 and 30, 1908; June 22, 1912; May 29, 1915.

the largest in existence when the plant was completed, are installed, the third unit being placed in operation last year. While the generators were rated at only 13,900 kva. each, tests proved they would exceed this rating so that with the forced-air ventilation provided they would carry 17,400 kw. maximum at 90 per cent power factor. The waterwheels are designed to just carry this load easily. Instead of having the oil pumps driven from the shaft, as is done at the Little Falls plant, they are driven by motors. The open-tank oil system is employed.

The buses and switching equipment are laid out in such a way that, while each generator and its corresponding transformer ordinarily operate as a unit, they can be operated in a number of other ways if the occasion demands it. To permit this flexibility of operation a single sectionalized low-tension bus is provided that can be formed into a loop bus by a cable running from one end of it to the other. Between each two sections of the bus is a 10 per cent reactor that can be inserted or cut out of circuit as desired. While each generator normally feeds into its corresponding transformer

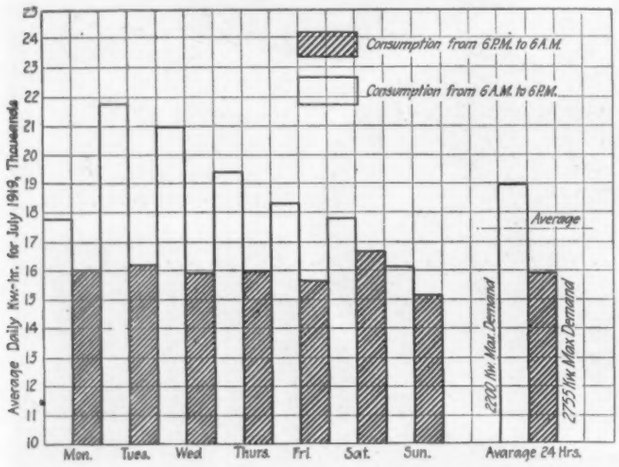


FIG. 3—EFFECT OF RANGE AND WATER HEATER LOAD ON RESIDENTIAL LOAD IN SPOKANE (JULY, 1919)

through an oil switch, it can be connected with its section of the low-tension bus and thence with any other transformer. This required three low-tension switches per generator installed. These are of the H-6 type.

Additional flexibility is provided by a loop-type high-tension bus with four oil switches per transformer. Through these any transformer may be connected with its own feeder or with any other feeder. Both 60,000-volt and 110,000-volt lines are supplied, and type K-15 and type K-36 oil switches are used respectively.

Reverse-power relays are used on the generators and transformers, selective relays between the generators and transformers, and inverse-time-limit relays on the outgoing lines. While the generator neutrals are not grounded now, they will be eventually and balanced protection will be provided.

The low-tension bus and switch layout is very interesting because it enables almost any desirable connection, permitting convenient placing of any apparatus that may be required and ready access to it. Two vertical tiers of bus compartments are placed parallel to each other with an aisle between and the oil switches overhead. In addition to the advantages mentioned, this obviates having switches and buses on different floors and gives a firm foundation for the switches.

TABLE II—AVAILABLE STORAGE IN RESERVOIRS

	Acre-Ft.	Sec.-Ft. Available
Coeur d'Alene	151,250	445 for 120 days.
Post Falls	2,750	Sufficient for daily load variations.
Long Lake	62,000	260 for 120 days.
Little Falls	1,740	1,000 for 20 hours.
Spokane	.....	Enough for daily load fluctuations.

The transformers, which are connected delta-delta for 60,000 volts and delta-star for 110,000 volts, are installed in fireproof compartments at one end of the wheel room, with the high-tension buses overhead and the low-tension buses behind them on the wall. Over them on a mezzanine floor are the low-tension buses and switches within sight of the control board. In another section of the bus and switch house running parallel to the low-tension room are the high-tension oil switches, disconnecting switches, bus-sectionalizing reactors and low-tension current transformers. The high-tension buses, which consist of iron pipe, are run overhead between the ceiling trusses, which are designed to give sufficient ground clearance. High-tension leads to the buses and switches come from uptakes in the floor below. On the floor above are the lightning arresters, choke coils, high-tension current transformers and line "disconnects." The horn gaps, lightning-arrester "disconnects" and terminal tower for the outgoing lines installed are on the roof.

MAGNITUDE AND NATURE OF LOADS

As mentioned before, the principal load centers are at Spokane, in the Cœur d'Alene district, and in the big Bend and Palouse districts respectively. Waste power is sold to the Pacific Power & Light Company, which has a maximum demand of about 6,000 kw. An additional 15,000 hp. is transmitted over the Intermountain Power Company's 110,000-volt line to the Chicago, Milwaukee & St. Paul Railroad electrification at Taunton. All power that the railroad does not use is transmitted over its bus line to the Puget Sound Traction, Light & Power Company. Commercial power in Spokane and suburbs amounts to about 40,000 connected horsepower. The electric range load on this system, which far excels the range load on any other system, is 20,000 kw. (connected). It is worthy of attention that 17½ per cent of the rural consumers have electric kitchens—*i.e.*, electric ranges and water heaters—and that there is a service connection for every four persons. Irrigation and municipal pumping together constitute 8,000 hp., although irrigation is not so prevalent in this territory as

TABLE III—GENERAL STATISTICS REGARDING WASHINGTON WATER POWER COMPANY

	1919	1918
Generator rating (kw.)	78,050	78,050
Maximum load (kw.)	63,220	33,956
Average load (kw.)	27,598	22,103
Energy generated (kw.-hr.)	241,761,350*	193,628,500
Yearly load factor (per cent)	43.6	65.09
Average monthly load factor (per cent)	78.0	70.60
Connected motor load (hp.)	62,400	58,200
Consumption (kw.-hr.)	187,395,293	148,458,721
Miles of transmission:		
60,000-volt	654	630
22,000-volt	32	32
Miles of distribution	700†	650†

* At present rate the energy generated for 1920 will be between 350,000,000 kw.-hr. and 400,000,000 kw.-hr.
† Approximate.

in some other parts of the West. About 4,000 kw. is supplied to the Washington Water Power Company's street railway, and connected loads in flour mills, railroad shops, meat-packing houses and lumber mills are about 3,000, 2,000, 1,500 and 1,000 kw. respectively.

PAST BUSINESS AND FUTURE OUTLOOK

Unlike many territories, eastern Washington was hard hit during the war because it had practically no war industries, men migrated to other sections and business in general was curtailed. As a result the electric service business suffered. Immediately after the armistice, however, electric service picked up, and it has increased rapidly ever since except for slight setbacks due to curtailment of mining in the Cœur d'Alene district owing to market prices and labor conditions. The future outlook is quite promising, and in addition to the natural growth in business it is expected that new loads will develop. For instance, some magnesite mines have been started north of Spokane, and the load may be particularly attractive if the operator converts this mineral to magnesium electrolytically. Pulp and paper industries are developing, and more activity can be expected because of the abundance of wood available and the composition wood products that can be marketed. Flour-mill loads are developing rapidly, and, since this section ranks as a great wheat-growing country, they promise to be still more attractive. In the territory Armour has built a meat-packing plant which is the only one of his plants driven entirely by central-station power, and a meat-packing center is expected to develop around it. Lumber-finishing mills are already being served, but until some use is found for the scrap lumber from sawmills which will prevent its being burned the opportunities for increasing service to such mills are rather slight.

UNDEVELOPED WATER POWERS IN VICINITY

As loads increase it will be feasible to develop other water powers in which Washington abounds, but at present most of the undeveloped sites do not have a sufficient market to justify their development. Among the water powers available are those at Priest Rapids and Kettle Falls, on the Columbia River; Z Canyon, on the Pend Oreille River; Salmon River, Clearwater River, Clark Fork of the Columbia River, Kootenai River, Priest River, other sites on the Spokane River, and possibly Lake Chelan if some of the engineering obstacles now apparent can be removed. Development of any of these sites will benefit all companies now operating in this territory if system interconnection is still further developed.

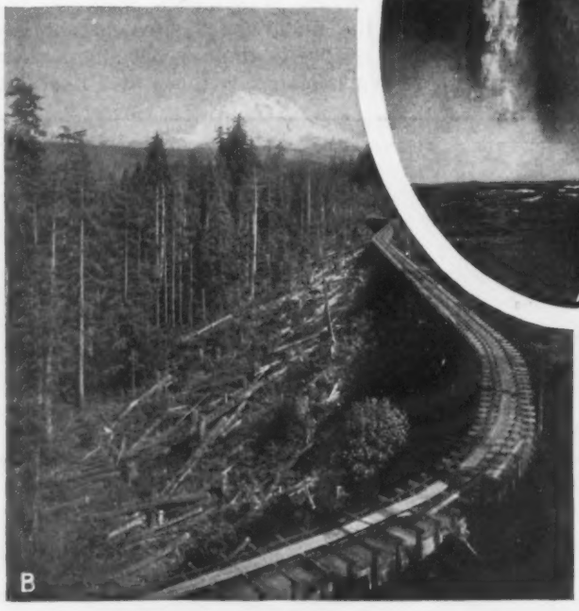
SHOSHONE FALLS DEVELOPMENT OF IDAHO POWER COMPANY ON SNAKE RIVER. STATION AT LEFT, OPERATED UNDER HEAD OF 210 FT.

The information for this engineering study was kindly contributed by members of the Washington Water Power Company, of which D. L. Huntington is president, W. E. Coman is vice-president and general manager and V. H. Greisser is chief engineer.

Water Powers That Provide Energy for Western Washington

Interior of 46,000-kw. Station on White River at Dieringer

A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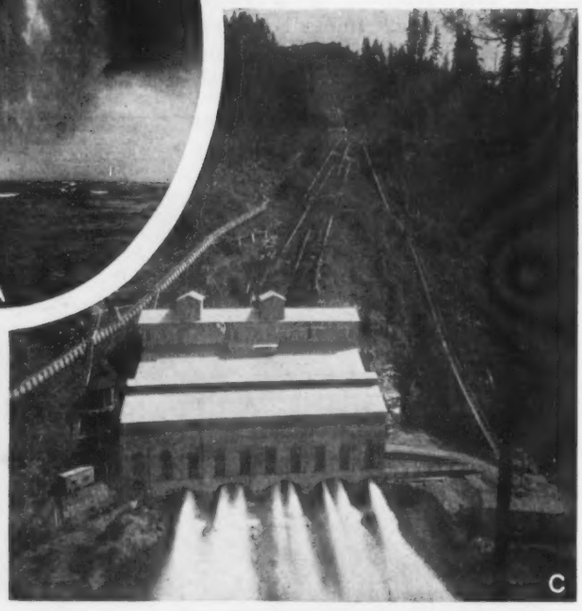
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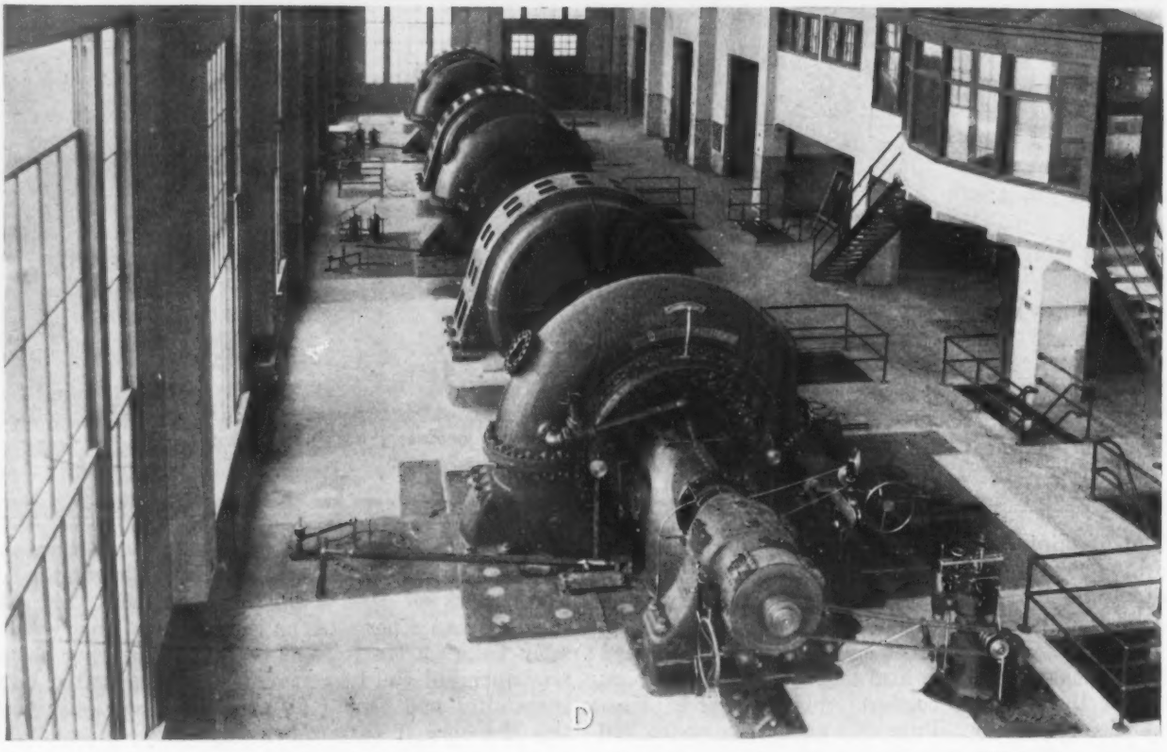

D

A—Snoqualmie Falls furnishes a 286-ft. head for about 20,000 kw. in generators underground on each side of the falls; in summer very little water goes over the falls.

B—Flume connecting Puyallup River with Electron plant; Mount Rainier, the source of the Puyallup and White Rivers, can be seen in the background of this illustration.

C—Electron, which is connected with bus at White River station, operates on head of 865 ft.

D—4T-wheel room of White River station, the largest and most modern hydro-electric plant of the Puget Sound Company.

Hydro-Electric Service West of Cascades

Although Competing with Municipal Plants, the Puget Sound Power & Light Company Has Been Able to Maintain a Firm Foothold by Reason of the High Degree of Service Reliability Assured

THAT portion of Washington west of the Cascade Range is as unlike the eastern part of the State in climate, topography, commercial activity, and hence electrical development, as day is from night. The rainfall is much heavier, there are no wide expanses of level land for agricultural development, the proximity to the ocean gives to the cities more of the trading character, and industry is more predominant. This section is provided with electric service almost entirely by the Puget Sound Power & Light Company, which has two distinct transmission systems, one extending northeast and southeast from Bellingham, the other taking in the territory on Puget Sound including Everett, Seattle, Tacoma and Olympia.

The company has an unusually diversified load such as results from serving prosperous seaport cities which do not have any single dominating industry that takes a large amount of power. For example, in Bellingham there are salmon canneries, cement mills, can factories, lumber and shingle mills, interurban lines, and rural light and power, with prospects of considerable mining load some day. Everett is essentially a manufacturing city producing lumber and its products. The principal load as far as magnitude is concerned, however, is that derived from the paper mills. Tacoma, which is at the head of ocean navigation on Puget Sound, offers excellent wharfage facilities for railway and steamship terminals, and these apply electricity in various ways. The chief industry is lumber, with flour milling ranking next. A large smelter, a shipbuilding yard and a street railway system are served with electricity, and energy is sold in bulk to the municipal plant in this city.

Seattle, the largest load center in western Washington, is the leading port on Puget Sound and has an enormous import as well as export trade. The largest single load in this territory is electric traction (about 20,000 kw.), the remainder being made up of (1) iron and steel-working shops, (2) coal mines, (3) lumber, box and paper mills, (4) office buildings, department stores, hotels and clubs, (5) flour milling, (6) shipbuilding, (7) can making and canning, (8) dock operations, (9) brick, tile and clay, (10) oxygen production, and (11) entertainment places, ranking about in the order of the groups named. The magnitudes of a few of these loads are given in the accompanying table with the average yearly load factors. Load factors, however, are no indication of the value of the loads to this company nor to a good many others, since the diversity factor is very high. Recently a large load (10,000 kw.) in the form of a contract with the Intermountain Power Company to serve the Chicago, Milwaukee & St. Paul electrified road has been acquired.

Hydro-Electric Plants in Seattle District

Because of the greater magnitude and importance of the load in the southern district, the principal generating plants have been developed in connection with this district. There are three hydro-electric plants. The oldest, rated at 11,000 kw., is at Snoqualmie Falls; the next newest is at Electron and is rated at 14,000 kw., and the most modern is at Dieringer, on the White River, with a rating of 46,000 kw. A second plant was built at Snoqualmie Falls in 1910 with a rating of 8,750 kw. Some of the characteristics of these plants are given in Table II. It may be noted that Electron has the highest head—865 ft. (263 m.) and develops the most power per second-foot (46.5 kw.), whereas White River has the largest storage—56,000 acre-ft. (68,880,000 cu.m.). Snoqualmie Falls has the highest river flow, however, and operates at the best yearly load factor and also most economically. Impulse wheels are used in both the Electron and Snoqualmie Falls plants, whereas center-flow, end-discharge Francis wheels are employed at White River.

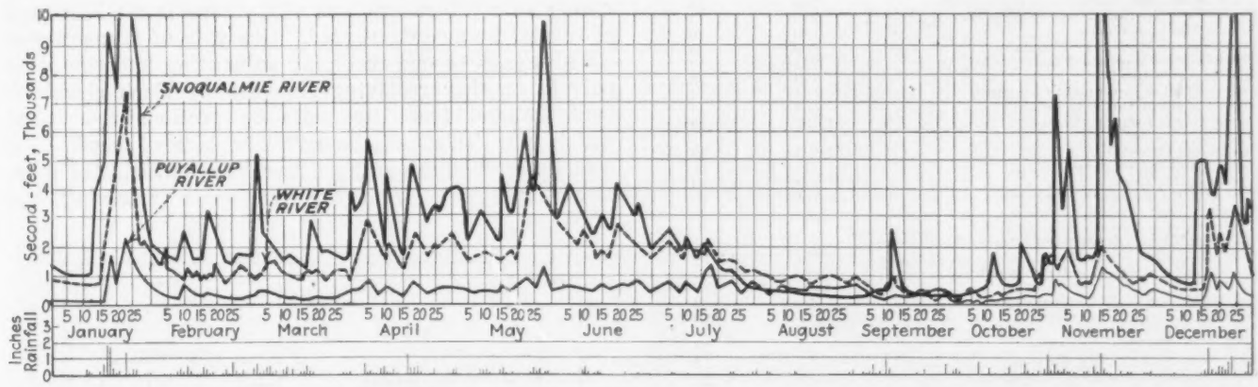


FIG. 1—VARIATIONS IN FLOW OF SNOQUALMIE, WHITE AND PUYALLUP RIVERS, WHICH FEED THE PRINCIPAL HYDRO-ELECTRIC STATIONS OF THE PUGET SOUND POWER & LIGHT COMPANY, FOR YEAR 1919

Connected with the southern system are also two steam* plants with a combined rating of 26,500 kw., the principal one, situated at Georgetown, having a rating of 23,000 kw. This plant is used chiefly to compensate for deficiencies in water flow and must stand ready to take an emergency load any time.

*The Puget Sound company was a pioneer in the burning of powdered coal and is still conducting extensive investigations in connection with its use in steam-heating plants. However, the company has not utilized coal in this form in its generating stations and will not do so until it feels that the experimental stage has been passed. Results of experience with powdered coal have been published in the ELECTRICAL WORLD.

Additional power is received over the Intermountain Power Company's connection with the Chicago, Milwaukee & St. Paul Railroad and the Long Lake development of the Washington Water Power Company when the railroad does not utilize all the power for which it has contracted. In the northern district is an 1,800-kw. hydro-electric plant on the Nooksack River. Power is also obtained across the Canadian border from the Western Power Company of Canada.

How Lines Are Laid Out to Assure Reliable Service

The method of serving the territory under consideration is best indicated by the transmission map on page 1056. As shown, a 55-kv. line runs from the Nooksack plant to Bellingham, which also receives energy from the Western Power Company of Canada on the north. A line running south to Burlington and branching to Mount Vernon and Contrete serves towns to the southeast. Lines operating at 11,000 volts run south from Mount Vernon, but a gap now exists between their southern extremities and the southern system.

The southern system is laid out so that the load centers are amply assured of reliable service from all or any of the three hydro-electric plants—Snoqualmie Falls, White River and Electron—more than one circuit running to each city. Seattle is particularly well provided with service facilities. For example, it may receive energy over two lines from Snoqualmie or White River and over another pair of circuits from the latter plant as well. White River in turn is reinforced by having Electron connected with its buses by two direct lines and one loop line to the east of White River, so that the two plants operate practically as one generating station. Additional flexibility in service is afforded by having a tie line between two of the transmission lines to Seattle. By this means if anything happens to either the load can be transferred to the other.

Not only is Seattle provided with four paths of energy and a local steam plant but these lines are so connected with substations that there is no likelihood of service being interrupted. One pair of transmission circuits goes to one receiving substation and the other pair to another receiving substation. Each circuit is kept isolated from its mate by sectionalized buses, which may be closed, however, in case of need. The remaining substations have two buses which are separately energized from the two main receiving stations but may be connected if necessary. Ordinarily

TABLE I—NATURE AND MAGNITUDE OF PRINCIPAL LOADS IN SEATTLE DISTRICT, SHOWING DIVERSITY

Load	Demand Kw.	Load Factor (per Cent)
Pacific Coast Steel Company	2,250	40
Washington Iron Works	700	28
Pacific Construction & Engineering Works	250	33
Seattle Machine Works	150	30
Puget Sound Machinery Company	200	24
Olympic Steel Works (off peak)	273	30
Steel furnaces (peak)	350	20
Hofeus Steel & Equipment Company	110	24
Vulcan Manufacturing Company	250	23
Pacific Car & Foundry Company	1,000	30
Coal mines (twenty)	4,800	50
Canal Lumber Company	1,000	21
Wood-box factories	1,500	20
Everett Pulp & Paper Company	1,092	65
Northern Pulp & Paper Company	600	40
Office buildings, department stores, hotels and clubs	2,500	14–52
Theatres and places of entertainment	800	10–40
Fisher Flouring Mills Company	2,250	60
Hammond Milling Company	550	50
Ballard Shipbuilding Company	50	20
Elliott Bay Shipbuilding Company	125	22
S. F. Duthie Shipbuilding Company	1,300	32
American Can Company	180	29
*National Fruit Canning Company	30	11½
*Fruit canneries	600	20
*San Juan Fish & Packing Company	225	44
Seattle Can Company	125	25
O. & W. R. R. & N. C. dock	50	20
Pacific Coast Steamship Company	70	32
Grand Trunk dock	30	15
Colman dock	50	19
East Waterway dock and warehouse	100	21
Todd dry docks	790	19
Denny Renton Clay & Coal Company	515	10
Seattle Brick & Tile Company	25	19
Seattle Oxygen Company	180	90
Air Reduction Company	125	50
Linde Air Products Company	225	74
Washington Burdette Oxygen Company	175	55

*Works three months of year.

TABLE II—CHARACTERISTICS OF PRINCIPAL HYDRO-ELECTRIC STATIONS OF PUGET SOUND POWER & LIGHT COMPANY.

Name and Location of Plant	Snoqualmie Falls		White River	Electron
Year completed	No. 1–1898	No. 2–1910	1911	1903
Rating	11,000	8,750	46,000	14,000
Average head, ft	225		440	865
Storage, acre-ft	350		56,000	88
Value of storage (kw.-days per acre-foot)	7.16*		13.6†	23.4*
Height of dam	20		Diversion dam only	Diversion dam only
Length of dam	217			
Water flow (sec.-ft.) max.	26,880		11,566	3,200
Water flow (sec.-ft.) min.	350		300	120
Water flow (sec.-ft.) average	3,000		2,450	600
Kw. per sec.-ft.‡	14.2		27	46.5
Yearly load factor, per cent	67.1		45.1	49.3
Ranks as regards operating cost:				
(a) Per kw. installed	1		3	2
(b) Per kw.-hr	1		3	2

*Storage for daily fluctuations in load only.
†As measured at intake of storage reservoir and used within 15 days. Evaporation and seepage in three months' time is 17 per cent.
‡Mean water level and at full-load efficiency.

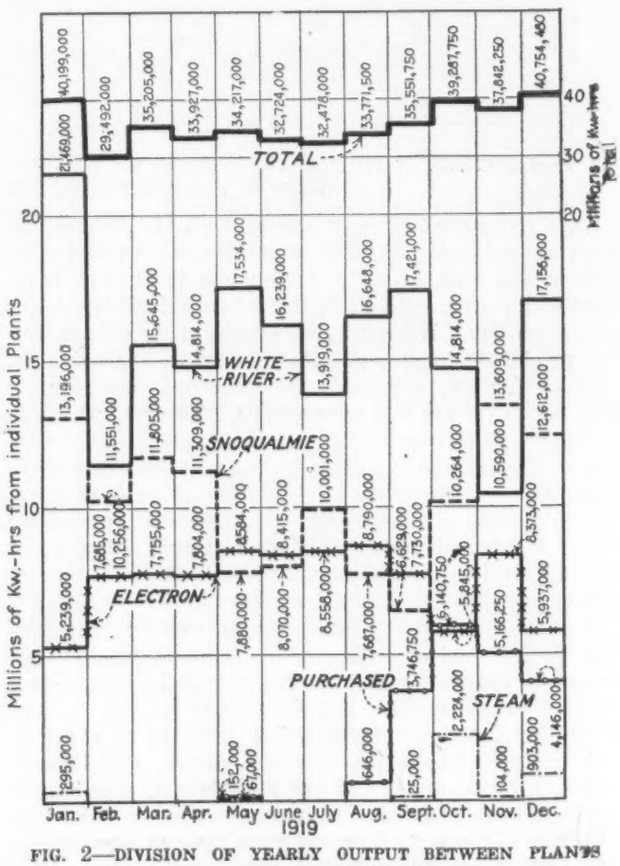
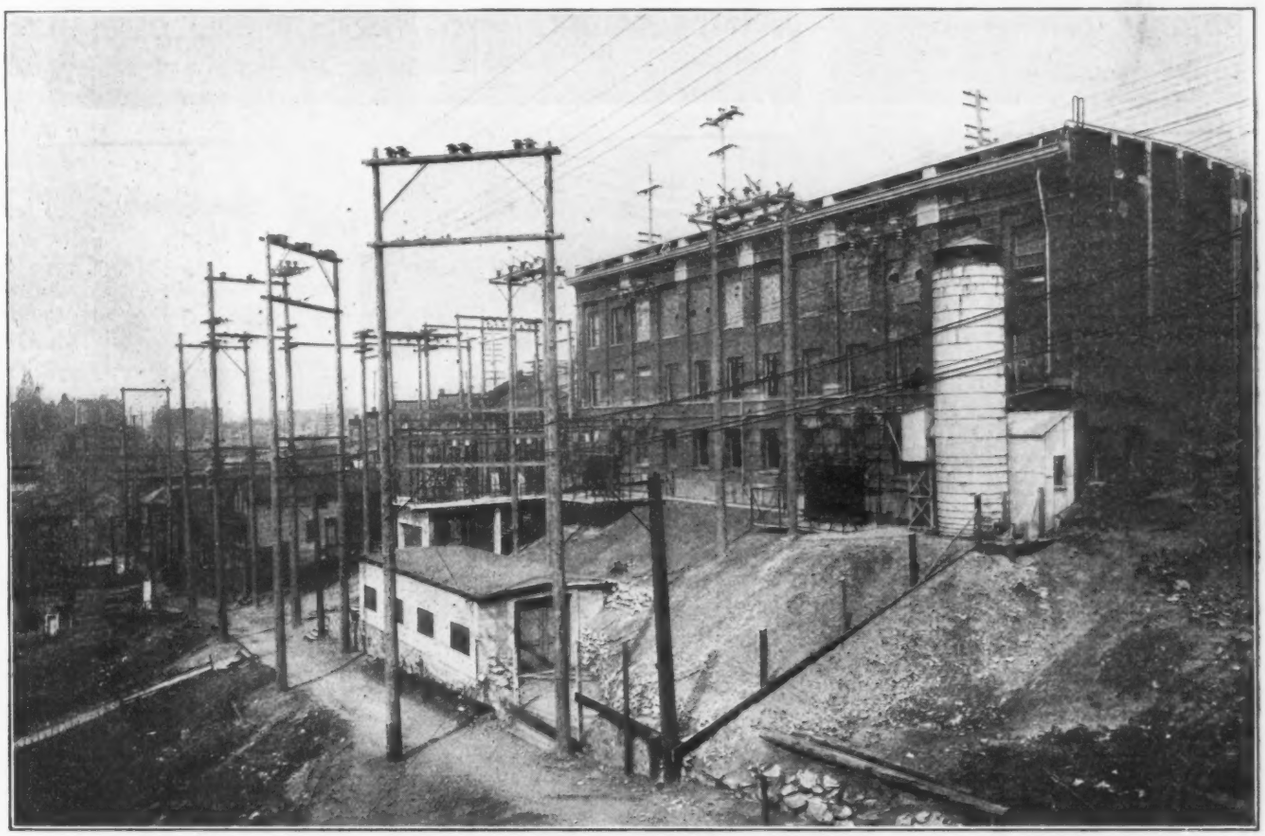


FIG. 2—DIVISION OF YEARLY OUTPUT BETWEEN PLANTS OF PUGET SOUND COMPANY

the high-tension feeders are kept isolated and the system is paralleled only on the low-tension side. Tie feeders are provided between all the substations and kept alive at one end to permit interconnecting when necessary.

Reliability of service is still further assured by relays. In the outgoing feeders at generating stations there are overload relays, and in all incoming feeders there are reverse-power relays. The overload relays in the lines from White River to Seattle are set for ten seconds definite time, while those in lines to Tacoma are set for three seconds. The overload relays at Electron are set for five seconds and those at Snoqualmie for eight seconds. Thus Seattle service will be the last to be interrupted, Electron letting go first, Snoqualmie second and White River, the largest plant, last.

Reliable service to both Tacoma and Everett is assured by duplicate transmission lines which are isolated at the receiving ends but arranged so either can energize any bus. The coal mines are served by a line running from Electron to Palmer which is tapped at Buckley by another transmission line from White River. A very effective line-inspection system has been in use for some time, and it also reduces the likelihood of interruption to service.



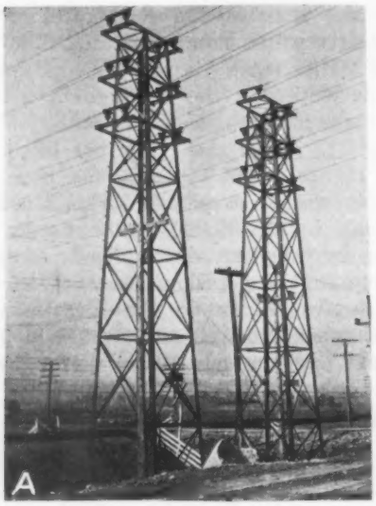
JEFFERSON SUBSTATION OF PUGET SOUND COMPANY, SHOWING INCOMING 55-KV. AND OUTGOING 13-KV. LINES

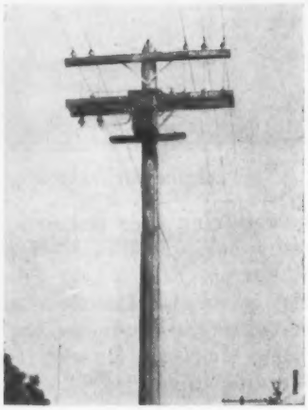
POSSIBLE INTERCONNECTIONS OF FUTURE

As can be seen from studying the maps, it will be possible to close some gaps and make loop circuits if enough benefits will be gained thereby. In some territories, especially in Seattle proper and between Everett and Mount Vernon, it is possible that as the 13,000-volt lines are extended they may tie together the northern and southern systems, although this capacity would not be sufficient to permit great exchanges of energy. A more effective tie would be afforded by running a 110,000-volt line between Mount Vernon in the northern system and Snoqualmie Falls in the southern system, but this will become feasible and economical only as the financial necessity which now faces all public utilities—the need of higher rates—is relieved and markets for energy are developed in the Bellingham districts great enough to make advantageous its connection with the southern district. Until then it is not likely that the water-power rights which the company now owns on the Baker River will be developed. This site has a possibility of 30,000 kw. to 45,000 kw. that may later be supplemented by another development of about 30,000 kw. Unless sufficient revenue can be earned to pay a more attractive return on the investment required, this development as well as others will doubtless have to wait. When the Baker River site is developed it will in all probability be connected with the 110,000-volt trunk line previously mentioned, the route now considered being indicated on the map. To the east of the Baker River site is the Skagit River development which is now under construction by the city of Seattle.

In the southern district to the east of the proposed trunk line, at Index, on the Skykomish River, is another water-power site that can develop 10,000 kw. to 20,000 kw. Natural head can be utilized and the plant could be connected with the 110,000-volt trunk line. Farther south, on the upper White River above Buckley, is still another water-power site which can develop about 60,000 kw. by running a penstock several miles upstream. This plant could be connected with the present White River plant.

Types of Transmission Line Construction Used by Puget Sound Company





A—Steel-tower lines at railroad crossing carrying four 55-kv. circuits from White River Station.

B—Flexible steel towers carrying White River lines.

C—Wood-pole lines from Electron to White River.

D—Line to Everett run through timbered tracts where excessive prices asked for cutting trees prohibited as wide right-of-way as would be desirable.

E—Two wood-pole 55-kv. lines along interurban line feeding Seattle.

F—Another 55-kv. line to Everett showing construction employed for 600 to 1,200-ft. spans in rough country and at river crossings.

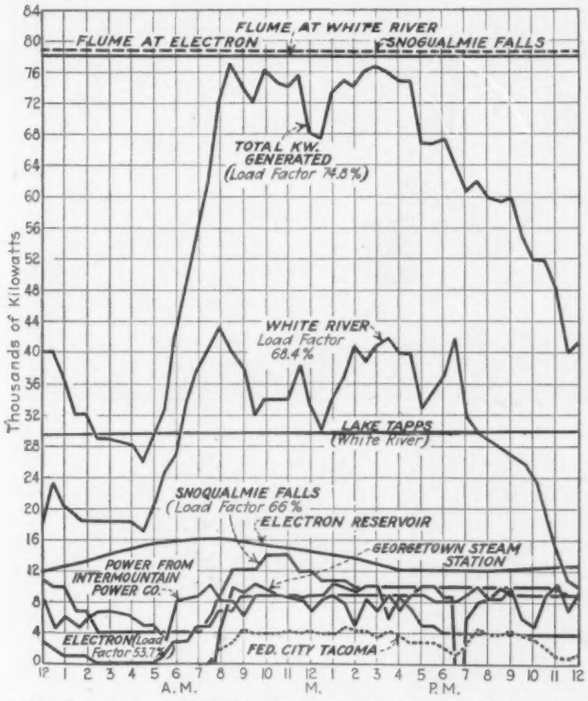
G—Single-phase 13,800-volt line on top crossarm feeds 13,800/230-115-volt transformer which is connected with three-wire crossarm below.

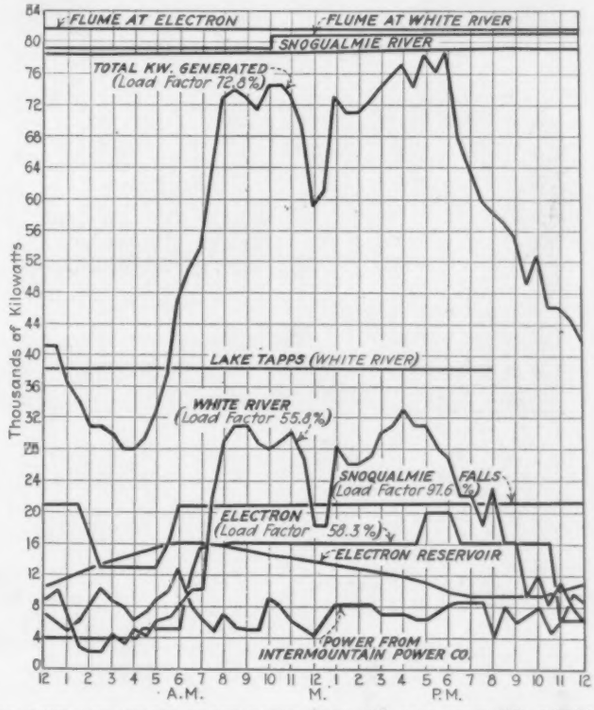
H—Steel tower substation serving coal mine. This substation is typical of those feeding the larger coal mines in western Washington.

I—A single-phase 6,600-volt line on the left side of crossarm feeds 6,600/230-115-volt transformer that is connected with three-wire secondary on right.

Just south of Olympia around Tenino is the northern terminal of a transmission line belonging to a company that connects with Vancouver. Vancouver in turn is connected with Portland, and from that system there is only a short gap to the lines of the Pacific Gas & Electric Company with its ramifications, interconnections and possible future connections. It is looking too far into the future, though, to think of the gaps mentioned being closed, because the benefits which would accrue would be negligible under present conditions, distances between generating centers being too great. Such interconnections could permit only small interchanges of energy, and the annual charges on lines large enough to permit large power interchanges would make the energy cost more than it could be purchased for locally.

Men on the Pacific Coast do believe, however, that it will be feasible some day to have a coastal trunk line into which all generating stations can feed and from which energy can be taken in bulk for distribution. The problems connected with this plan are not so much technical as financial, since a main question is how the charges for line usage, rates for energy, etc., can be equitably fixed.





FIGS. 3 AND 4—PUGET SOUND COMPANY PLANT LOADS FOR TYPICAL LOW AND HIGH FLOW DAYS (OCT. 10 AND NOV. 17, 1919)

How Load Is Divided Between Stations

The operation of water-power plants with relation to each other is a problem that is handled differently in different territories, but stream-flow conditions exist in this country that may be interesting and the fundamental principles involved in operation can be applied anywhere. The three principal plants—Snoqualmie Falls, White River and Electron—take water from three streams quite different in characteristics.

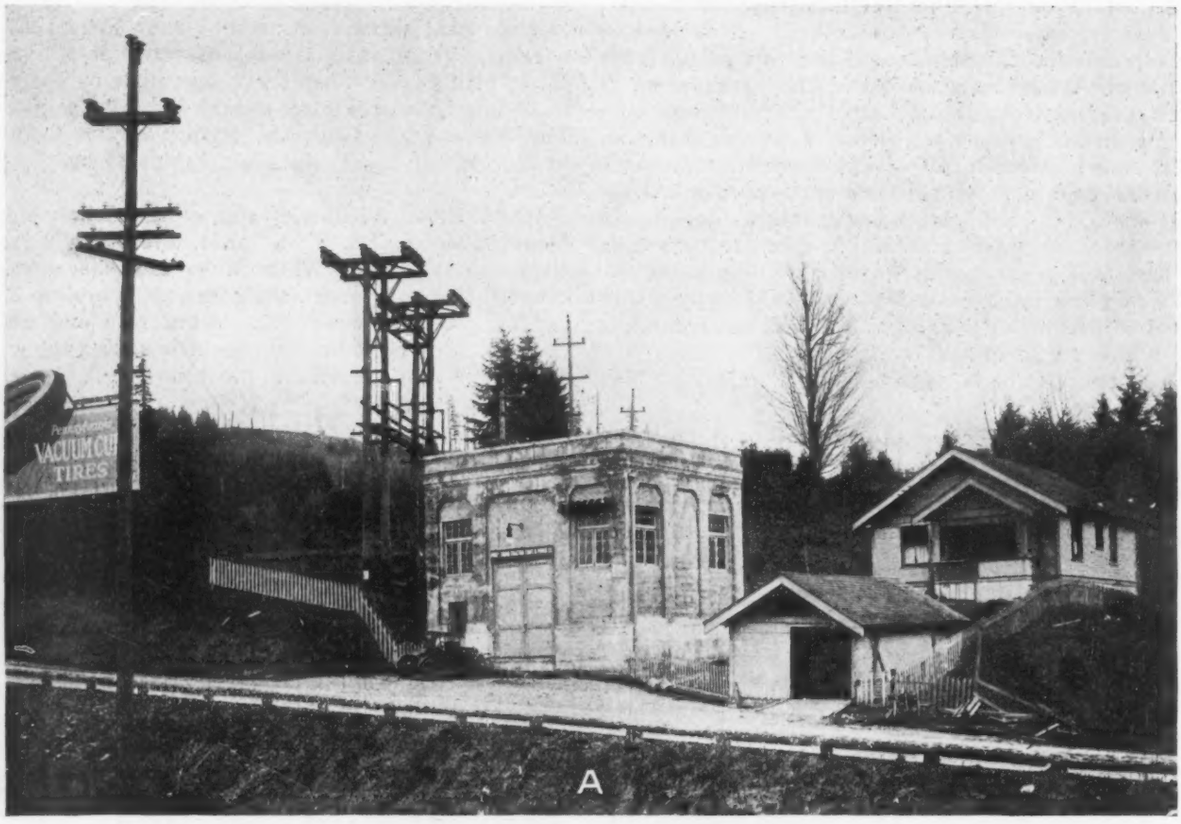
The Snoqualmie River, which feeds Snoqualmie Falls, is a clear-water stream which receives its water from melting snows and rains and none from melting glaciers. It has a very large drainage area covered with heavy timber that regulates the run-off to a great extent. The dry season ordinarily occurs during August, September and October, and the rains are heaviest in winter. On the other hand, Puyallup River, which feeds Electron, rises on the western side of Mount Rainier—14,526 ft. (4,420 m.) high—and receives its water principally from melting glaciers. Of course, it also receives some water from melting snow and rains. As a result the greatest amount of water is discharged through this river when the temperature on the slopes of Mount Rainier is high enough to melt the glaciers. The flow subsides when the glaciers quit melting, but by this time Snoqualmie River begins to benefit from rains.

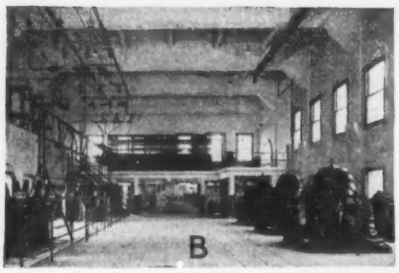
White River tributaries rise on the north side of Mount Rainier, but at a lower level than Puyallup River. As a result White River has characteristics between those of Snoqualmie River and Puyallup River, receiving water from melting snow, rain and melting glaciers. The rains build up the flow during the winter when snow and glaciers are not melting. As spring progresses the snow melts, and when the warm summer weather occurs the glaciers melt. Thus, except for a short period, usually during October, the river flow is relatively high. The flow in each river is given for the year 1919 in Fig. 1.

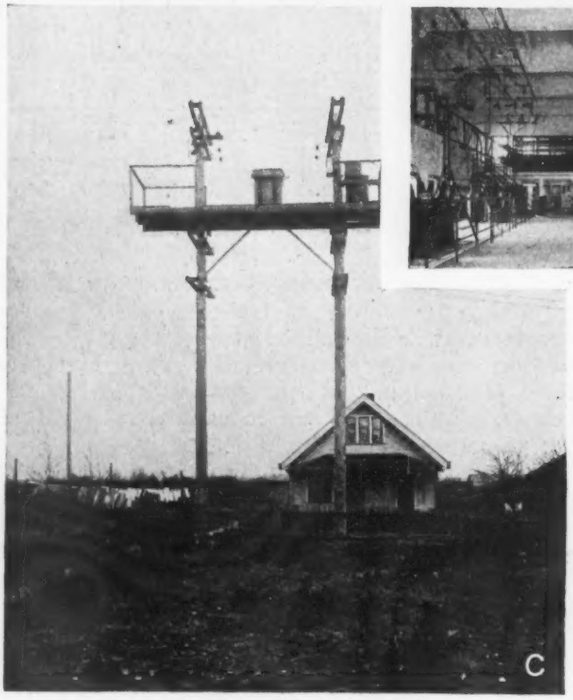
To show how the plants utilize these stream characteristics to the best advantage, the division of total load between plants is given for the year 1919 (Fig. 2) and also for typical high-water and low-water days (Figs. 3 and 4). In studying these curves reference should be made to Table II, which gives the average heads, water flow and storage at each plant.

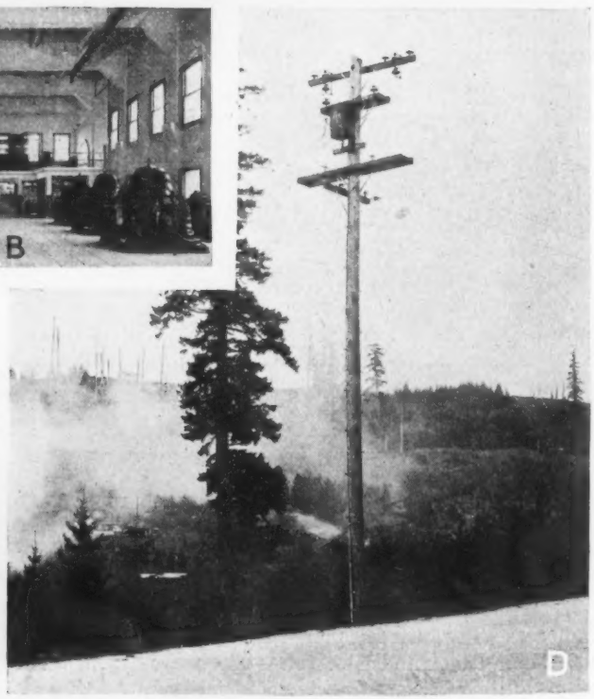
The storage at the White River plant is equivalent to 18,000,000 kw.-hr., while that at Snoqualmie and Electron is only 60,000 kw.-hr., just enough for daily fluctuations in load. For this reason White River storage is allowed to accumulate as much water as possible during the wet season, and Snoqualmie and Electron are used to carry their maximum loads. Of course,

Distribution Features in Rural Sections Fed by Puget Sound Power & Light Company









A—Bothell substation transforms 1,500 kva. from 55,000 volts to 13,800 volts, feeding small towns and rural sections within 15 miles radius; shows cottage and garage for district agent.

B—Main operating floor of Jefferson substation.

C—Pole-top 13,800/2,300-volt transformers and automatic voltage regulator. The structure is designed for three ultimate units of 100 kva.

D—13,800/130-volt transformation for scattered rural distribution.

TABLE III—VOLTAGE OF PRINCIPAL LINES OF PUGET SOUND POWER & LIGHT COMPANY, WITH SIZES OF CONDUCTORS

	Voltage	Size of Conductor
Nooksack (g)—Bellingham (g)	55	No. 2 copper equivalent
Western Canada Power Company—Bellingham (g)	55	No. 2 copper equivalent
Bellingham (g)—Mount Vernon via Burlington (j)	55	No. 1 copper equivalent
Burlington (j)—concrete	55	No. 1 copper equivalent
Mount Vernon—La Conner	13	
Mount Vernon—Stanwood	13	
Snoqualmie Nos. 1 and 2 (g)—Everett	55	No. 4 copper
Snoqualmie Nos. 1 and 2 (g)—Everett via McAleer Lake	55	No. 4 copper
Loop around Seattle	13	
Snoqualmie (g)—Renton (j)	55	Two 4/0 aluminum
Renton (j)—Seattle	55	Two 4/0 aluminum equiv.
Electron (j)—White River (g)	55	Two 4/0 copper
White R (g)—Renton (j)	55	Two 4/0 copper equiv.
White River (g)—Buckley (j)	55	No. 4 copper
Electron (g)—Buckley (j)	55	No. 4 copper
Buckley (j) to Palmer	55	
White River (g) to Tacoma Smelter and Olympia	55	2/0 aluminum No. 4 copper
White River (g) to Tacoma	55	2/0 aluminum
White River (g) to Seattle	55	Two 4/0 copper
Tap to Tacoma	55	Two No. 1 copper, No. 1/0 copper
Tie between Renton Junction—White River—Seattle; White River-Renton	55	4/0 copper equivalent
Georgetown (g) connected with one of White River-Seattle lines	..	

(g) Indicates generating station; (j) indicates junction point.

as much of the water that cannot be stored as possible is used to generate power at White River during high-flow season because it is the largest plant. Electron can develop the most power per second-foot, however. During low water Snoqualmie and Electron are operated to utilize as much water as possible, White River is operated to carry a fairly uniform load, and the fluctuations in total load are carried by the steam plant at Georgetown. It is usually necessary to start drawing down White River storage (Lake Tapps) in the last part of August or the first part of September. If there are prospects of a prolonged dry season, less water is drawn off and the steam plant is operated at a heavier load. Fortunately, as pointed out before, the low-flow period in Puyallup River occurs later than in the other two rivers, so that the Electron plant can help to make up any deficiency in the dry season. Power from the Intermountain Power Company cannot be depended on for help during low water because of the fact that the Puget Sound Company receives only surplus power.

The division of load for typical low-flow and high-flow days is better shown by Figs. 3 and 4. On the dry day, it may be noted, Electron and Snoqualmie were loaded for as much as they would carry, the reservoirs being drawn down during the day and allowed to fill up at night. However, White River had to carry the base load and Georgetown steam station had to help. The situation was made more serious than usual by the fact that the Tacoma municipal plant required emergency service on this day. On the high-flow day Electron and Snoqualmie were able to carry larger loads and White River could be operated at less load to allow its reservoir to store water. The idle generator capacity at White River can be used to correct for power factor during the high-flow season.

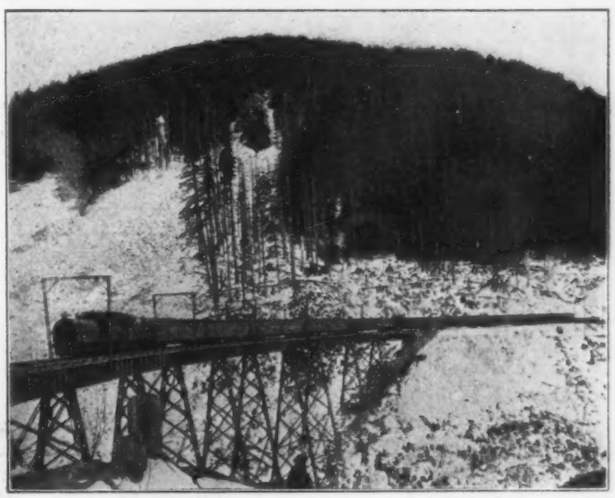
TABLE IV—GENERAL STATISTICS REGARDING PUGET SOUND POWER & LIGHT COMPANY

	1919	1918
Generator rating	119,500	109,500
Maximum load	101,400	99,200
Average load	51,500	48,700
Energy generated (kw.-hr.)	447,576,000	423,092,000
*Load factor (yearly)	50 75	49.1
Average (monthly), per cent	63.6	63.8
Connected motor load	100.200	86,300
Loss in transmission, transformation and distribution	96,638,000	87,129,000
Consumption (kw.-hr.)	358,000,000	338,200,000
Miles of transmission	.....	.....
55,000 volts	566	566
13,000 volts	181	160

* Supplied power to Tacoma for short periods, thus increasing maximum demand and reducing load factor.

PROSPECTS OF FUTURE DEVELOPMENT

The prospects are that the central-station load in western Washington will become still more diversified because, as was pointed out before, Seattle handles an enormous amount of import and export trade which will either directly or indirectly affect electric service development. Besides, as manufacturers find that their markets in the Far West and in foreign places easily reached from the Pacific Coast ports justify locating factories in the Far West the territory around Seattle is quite certain to become an industrial center, its excellent ports and transcontinental railroad facilities and its delightful climate conducing to its being worked at a high efficiency the year round.



TRAIN ON THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY'S OTHELLO-TACOMA ELECTRIFIED DIVISION, FORMALLY OPENED FOR SERVICE MARCH 5, 1920.

Already large parts of the wool, cotton, silk, rubber and flax that are brought into Seattle are being converted into finished products in the city's mills, and more textile plants are likely to be established there because the humidity is almost ideal for textile manufacture. A great many automobiles are used on the Coast, and the demand for rubber tires has warranted their manufacture in the West. Automobile assembling plants with their electric japanning ovens are also being located there. Steel shipbuilding, which was stimulated by the war, is continuing.

Lumbering has always been a predominant industry in the Northwest, and as the supplies of timber elsewhere in the world become depleted, which is fast occurring, this industry will increase in importance. Timber will not become exhausted if proper protection from fire is given to second growth and if it is made financially possible to hold cut-over timber lands until the second growth is ready for cutting. While the logging industry has not been served extensively by

central stations so far, because of the fact that "hogged" fuel can be used by logging companies to generate power more economically, the operation of lumber, shingle and lath mills is quite generally performed by electric service from central stations. Paper making, which is also dependent on a supply of wood for some grades, is an important and growing industry.

Much of the level land in western Washington is already used for dairy purposes, and as timber land is logged off more grazing space will be available for cattle. At present large milk-condensing and canning plants, which are electrically operated, are situated at Auburn, Kent, Stanwood, Mount Vernon, Ferndale, Lyndon and Everson. Since these have developed in the last six years, it can be imagined what the size of this industry will be in the next few years with the facilities for cattle grazing increased.

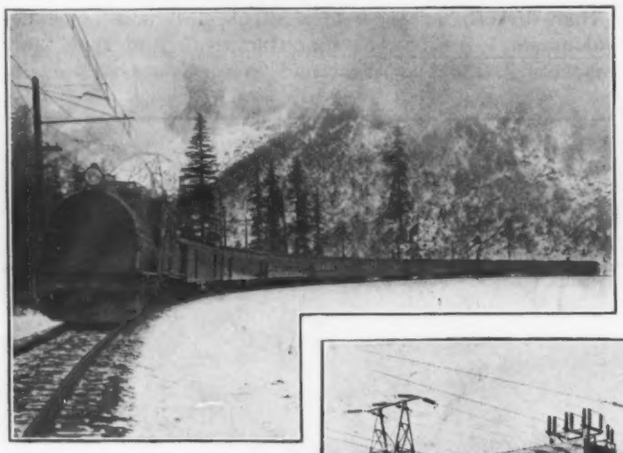
COAL MINES USE CENTRAL-STATION ENERGY

In the northwestern section of the State are enormous deposits of limestone, clay, talc and magnetite. Portland cement is already made in large quantities near the Baker River site. Brick and tile are being manufactured by the aid of electricity, and some magnetite mines have been opened. When some means of economically making aluminum out of clay is developed there should be an attractive electrolytic load for the transmission company. Practically all of the coal mines in western Washington are electrically operated now. The operators have shut down their isolated plants because it was not unusual to have two or three breakdowns a week lasting as long as six hours each. Now they secure reliable, uninterrupted service from the Puget Sound company over lines which are fed from two plants.

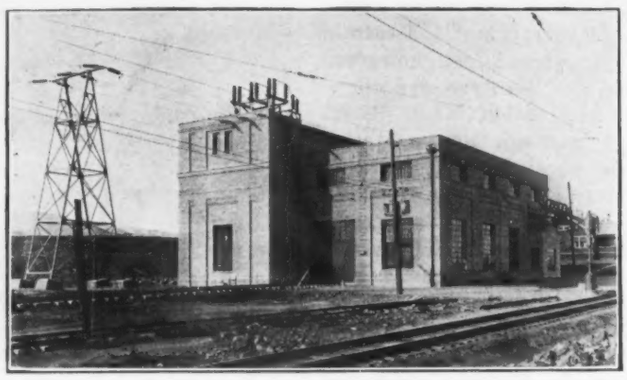
Fish canning is an important industry, but the load is light and lasts only three months of the year. Flour mills ar. fast developing, and electricity is being used at ship terminals for unloading and loading vessels, transporting material in trucks and similar purposes.

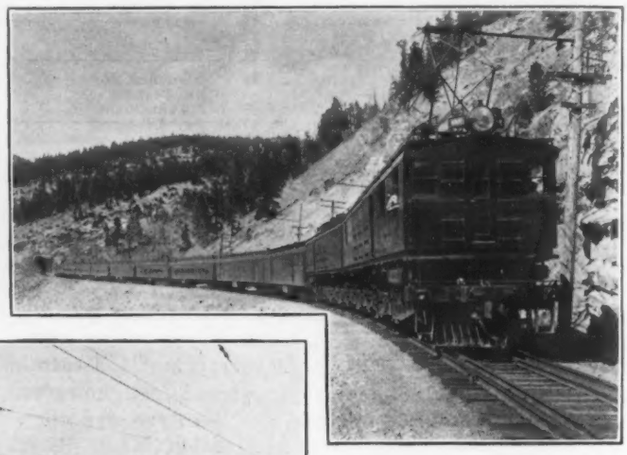
ELECTRIFICATION OF RAILROADS

The contract to supply the Chicago, Milwaukee & St. Paul Railway with part of the energy for the Othello-Tacoma electrification constitutes quite a large load (10,000 kw. maximum demand). As more electric locomotives are placed in operation the energy required will increase. Several other railroads enter Seattle, and as these electrify their mountain divisions it is quite likely that they will have to call on the Puget Sound Power & Light Company for energy west of the Cascades, because it appears hardly wise to depend absolutely on transmission lines from the East over the high, windswept territory.



At left, Olympian Express, the first train to be propelled over Cascade Range under electric power. The division is served by the Puget Sound Power & Light Company and Washington Water Power Company through lines of the Intermountain Company.





At right, train being hauled across Rocky Mountain division of C., M. & St. P. R.R. by electric locomotive of a different type served by Montana Power Company. In center, one of the substations feeding the C., M. & St. P. R.R. electrification.

ELECTRIC LOCOMOTIVES ON TWO DIVISIONS OF C., M. & ST. P. R.R. OPERATED FROM CENTRAL-STATION TRANSMISSION LINES

Information for this article was kindly contributed by engineers of the Puget Sound Power & Light Company, Seattle, of which A. W. Leonard is president, W. H. McGrath vice-president, G. E. Quinan chief engineer, John Harisberger general superintendent, S. C. Lindsay electrical engineer, M. T. Crawford superintendent of transmission and distribution, and H. J. Gille sales manager.

THE *cost of steam power is steadily increasing. Power can be developed at far less cost by water. Energy developed by hydraulic plants and converted into electricity can be distributed cheaply and over wide areas. Applications of electricity are multiplying. Demand for electricity, for industrial purposes through motors, for electrochemical use and for domestic convenience is growing with great rapidity. Beyond this, there is the unquestionable fact that trunk lines of railways are certain to depend in the not distant future on electric locomotives wherever energy can be obtained at a reasonable price.*—PRESIDENT DODGE *of the International Paper Company.*

Public Utility Financing

Plan for Basing Rates on Issues of Bonds and Stock—Need for Cash Reserve—Increases in Earnings Should Be Divided Between Company and Public—Financial Co-operation Among Utilities Urged

By EDWIN O. EDGERTON
President California Railroad Commission

THE biggest single problem before the public utilities today is financing; that is to say, obtaining money at reasonable rates sufficient adequately to meet the constantly growing demands of the public for service. Particularly as to the electric power companies the demands for money for development have become so great that, looked at from the standpoint of the consumer, if there are any unnecessary obstacles in the way of financing they should be swept away and every effort should be made to encourage investment in public utilities.

Unless our public utilities are expanded and developed industry and agriculture will be restricted. Practically all utilities are today in a condition where they must make the greatest proportionate development in their histories, else they will fall far short of meeting demands for service. Money is not coming freely to the utilities, and the reasons for this should be examined with an open mind to arrive at the truth in order that necessary steps shall be taken to remedy what may become a very bad condition. That the utilities can be put in a position to finance economically and in the real interest of consumers is my confident belief, and I will make certain definite suggestions in hope that they may lead to real and prompt results.

The result to be attained is that the investors shall have tangible and substantial assurance of the security of investment, continuity and certainty of earning, plus the possibility of increased earning through efficiency and economy of management, while the consumer shall have assurance of sufficiency of service through ample financing at a minimum of cost and further shall have a simple and understandable method of determining whether his own contribution is fair.

Two Classes of Investment

Money for investment may be divided broadly into two classes—speculative money and conservative money. Speculative money may be described as money invested on a basis of considerable chance being taken as to security; hence possible ultimate earnings must be very large to justify the taking of such chances. Conservative money may be described as money invested on a basis of practical certainty both of security and return on the investment. This results in the minimum of earnings being required.

Speculative money is not available for public utility investment because regulation and other causes prevent the possibility of large returns; that is to say, large as compared with private enterprises. To obtain conservative money in large amounts the investor therefore must have reasonable assurance that his dollar will remain intact and that it will while invested steadily yield the return expected.

Neither the public utility company nor the regulating body can give any absolute guarantee either as to security of investment or certainty of return, but with intelligent regulation and honest and competent management of the company, in my judgment, the investor in a public utility property can have greater assurance than in any other investment short of governmental guarantee or the purchase of governmental securities.

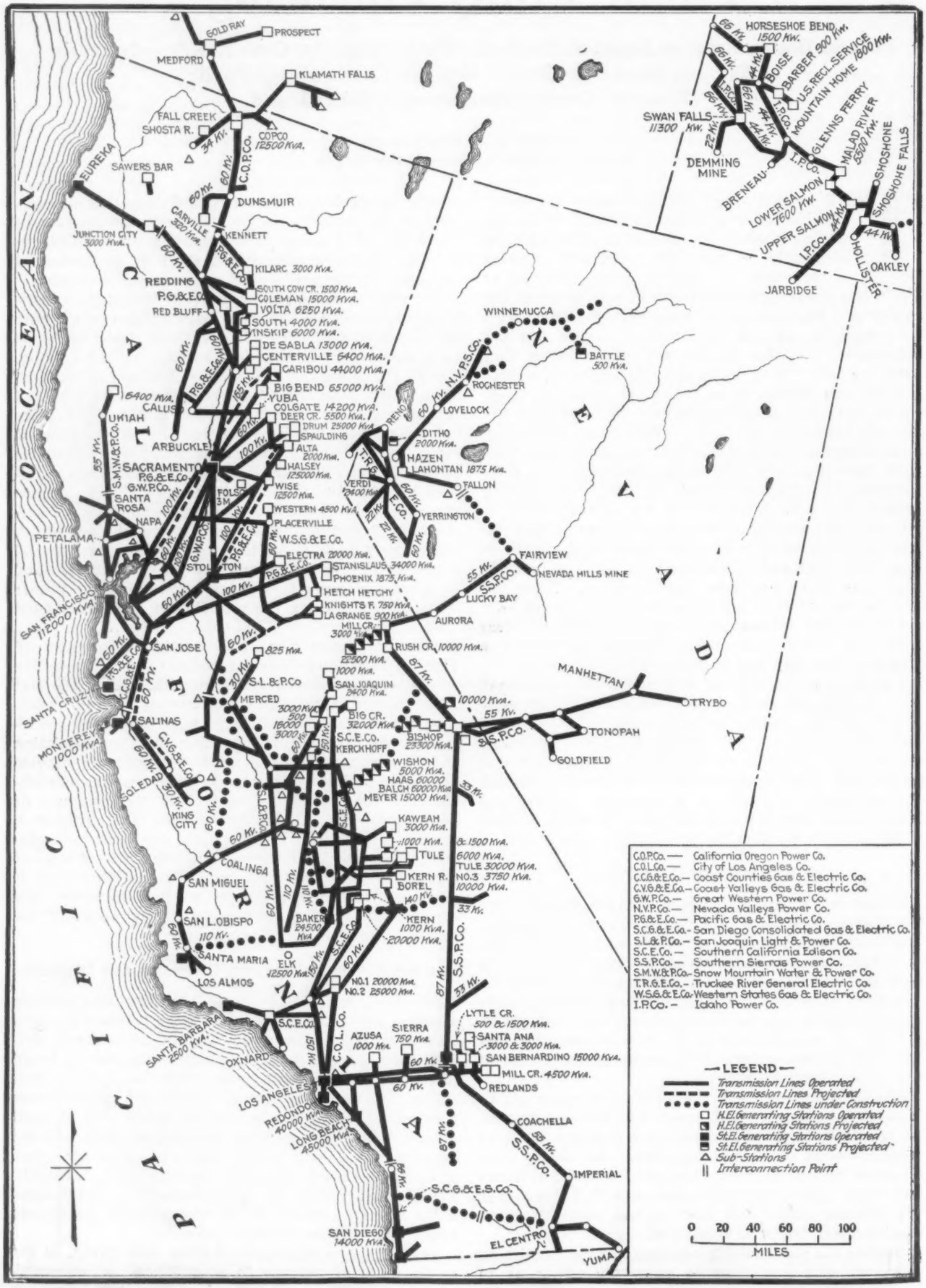
For reasons which appear perfectly logical the history of regulation shows a marked disinclination on the part of regulating authorities to recognize stocks or bonds as a basis for determining revenue or rate fixing. Before the advent of the state public utility commissions, which have control of the issuance of stocks and bonds, city councils and local authorities fixed rates but had no control of bonds or stocks. On the advent of the state regulating authorities it was found impossible at once to make over or revamp the outstanding capitalization of the utilities, and, being unwilling to assume any responsibility for the sometimes unduly large outstanding issues of securities, the regulating bodies immediately took a position of standing on physical valuation as a rate base and insisted at all times—and in a large measure they today insist—that the proper basis for considering the contribution the public must make for service is physical value of plant.

This has given rise to a constant discussion of physical valuation in rate proceedings and to the feeling on the part of investors that, notwithstanding the fact that the regulating body authorizes an issue of securities, nevertheless the purchaser must take such securities with a definite understanding that the regulating body assumes not even a moral obligation to provide dividends or bond interest. In other words, notwithstanding the substantial control of the revenues of the company by the regulating body, the investor is made to realize that it will on the one hand authorize issuance of securities dependent wholly for bond interest and dividends on revenues, while on the other hand it announces in advance that it will not recognize this capitalization as imposing upon it any necessity for adjusting rates in order to care for it.

Basing Rates on Required Dividends and Interest

My first suggestion is that utility commissions establish and recognize a sound issue of securities and thereafter fix rates based on the bond interest and dividend requirements of these securities. Consumers would clearly understand that rates must be such as will enable the company to pay dividends and bond interest regularly; the utility management would have at hand a ready means of measuring its revenue needs, and the investor would have every reasonable assurance that when he purchased securities the regulating authority would, in so far as the business made it practicable, authorize rates which would maintain his investment intact and produce a regular return.

This, it seems to me, would make rate fixing, as far as the total of revenue to be produced is concerned, almost automatic, and instead of the long-drawn-out



DISTANCE BETWEEN POINTS OF ENERGY GENERATION AND UTILIZATION IN CALIFORNIA HAVE CALLED FOR LONG, HIGH-VOLTAGE TRUNK LINES

controversies which now occur in rate proceedings, wherein all the intricate and complicated questions of depreciation, various methods of valuation and so forth are discussed over and over again, we should have a comparatively simple problem. The total amount of revenue necessary to meet operating expenses, depreciation, bond interest and dividend requirements could readily be ascertained and rates adjusted accordingly.

It is my observation that it is very much in the public interest that money be obtained by our great public utilities at the lowest possible rates, and it follows for the reasons already given that the public is positively benefited the greater the assurance to the investor of security and return.

BENEFIT OF A CASH RESERVE

It would be humanly impossible to fix rates with such nicety as to keep net revenue at an exact figure. Experience has shown that conditions sometimes change suddenly, so that instead of attempting instantly to meet a change in net revenue by an adjustment of rates, thus constantly changing rates and creating a very unsatisfactory condition, it would be better to so provide that cash should be available to pay dividends and interest notwithstanding fluctuations in net revenue.

I therefore suggest that there be set up a cash reserve, probably under the control of the regulating commission, this reserve to be set aside out of rates in the periods when operating expenses are comparatively low and net earnings high and to be held for the purpose of insuring the payment of interest and dividends. The result would be that when operating expenses mounted it would not be necessary to increase rates unless the increased cost continued for long periods, because the reserve could be drawn upon safely to carry the company's fixed charges, and as operating expenses decreased the reserve would build up again, thus acting as a visible and effective storage reservoir of money to keep the stream of bond interest and dividends running.

DIVISION OF INCREASED EARNINGS

As it is in the interest of both the consumers and the company that service be produced at the minimum of cost consistent with good service, sufficient inducement should be given to the managements of public utilities to operate as economically and efficiently as possible. For this purpose I suggest that regulating bodies lay down the rule (sanctioned by statutory enactment in California) that increased net earnings caused by increased efficiency and economy of management over a predetermined standard be shared in fair proportion between the company and the public. This would answer the criticism of present regulation that it holds out no real incentive for initiative.

Of course, there are companies whose outstanding issues of stocks and bonds are such that no regulating body would recognize the sum in total or agree to fix rates that would at all times care for interest and dividends. Moreover, it must be recognized that in no event short of bankruptcy and sale on foreclosure can owners of stocks and bonds be compelled to surrender them. So I advocate that the suggestions heretofore made be embodied in a plan and that the companies be offered the option of adopting this plan, meeting all of its requirements and of course enjoying its benefits, or continuing in the old way. I believe the plan could legitimately be made sufficiently attractive to be a substantial inducement to the owners and creditors of an overcapitalized company to come in under its provisions and voluntarily reduce the par of their holding to obtain fewer but sound securities.

Can one not at this point say with confidence that the suggestions above made involve problems and interests common to all of the utilities, or at least common to each class of utilities? Yet, strangely enough, there has been an utter lack of conference, co-operation or joint thought or action among the utilities on the question of finance. In practically every other activity we find the companies in a given class contributing experience, study and frequently money, for the good of the industry as a whole, but when dealing with finance they draw apart from one another and maintain complete aloofness.

NEED FOR FINANCIAL CO-OPERATION AMONG COMPANIES

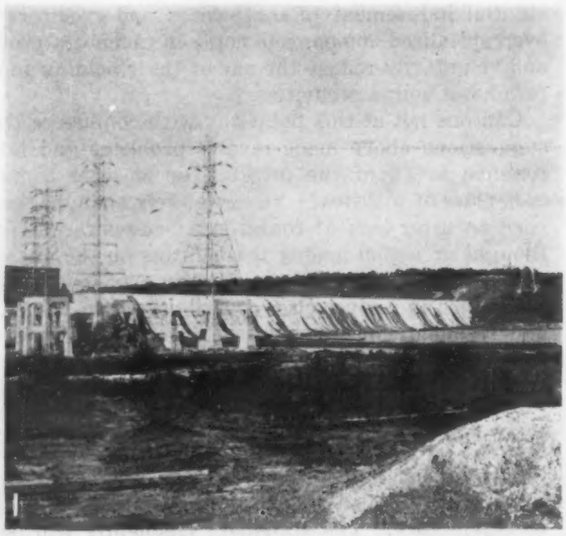
The approach of the utility to a regulating commission for consideration of its financial needs is usually unsatisfactory. The statement frequently will be made that more revenue is necessary in order that money shall be obtained for development, but when the utility's representatives are requested to substantiate this statement the showing is seldom adequate. The regulating body is usually told that which all will admit, to wit, that utilities cannot finance unless they have adequate revenues; but when it comes to a showing that the granting of added revenues will have certain definite results in the marketing of definite securities, the regulating body is usually left to rely upon the mere assertion of the utility's representatives.

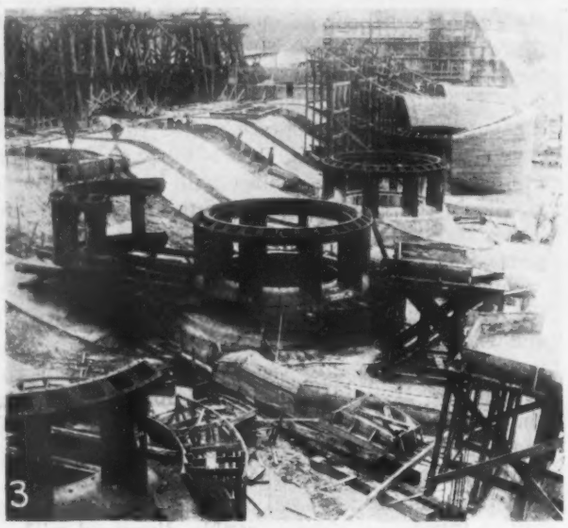
Surely such factors in the marketing of securities as the condition of the investing mind, the available money and the requirements to obtain money are capable of some assembling into reasonable and logical rules or principles. It would seem not impossible that by getting together in conference the financial representatives of the utilities could discuss the problem of raising large sums of money for the whole industry in a given state; that the existing financial condition of the various companies involved could be frankly discussed with a view to bringing those which were not sound up to a proper basis. Such matters as the proportion of outstanding bonds to total assets could be considered and some general rule agreed upon toward which all should work. The question of the time when issues of securities of any class should be brought out, in consideration of the ability of the market to absorb such securities, could also be reviewed. It seems reasonable to suppose that by conference and co-operation reasonable plans could be laid for the amounts and the times when each or all of the companies should make offerings to the public with mutual advantage.

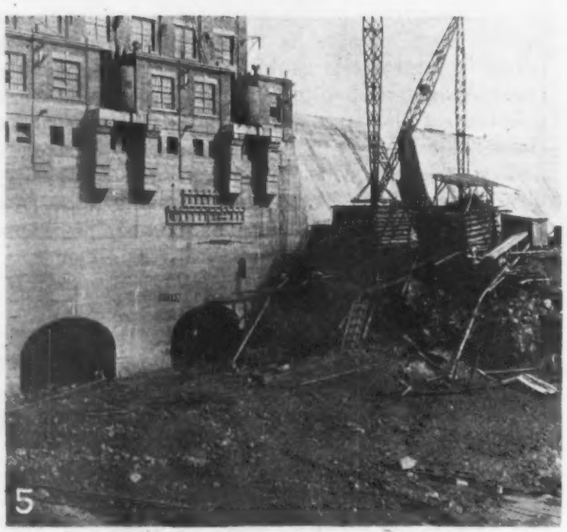
I have in mind co-operation among the utilities, going even to the point where the financial experts of all could consider a given proposed issue by one of the companies and having perfected the proposal could then publicly indorse the issue as sound from the standpoint of all the utilities.

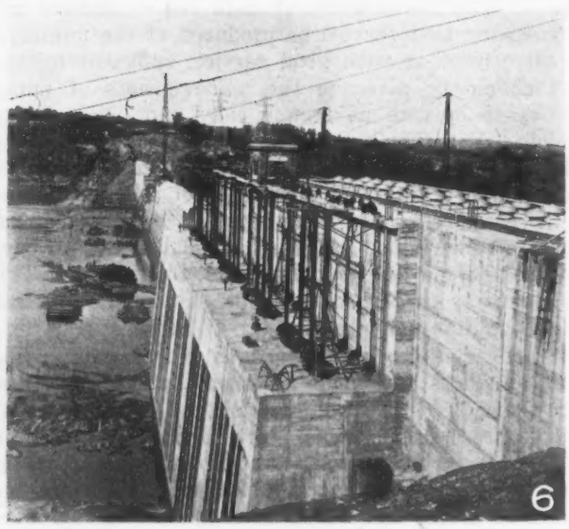
In considering public utility financing for the present and future, old methods must be discarded when they cause waste and loss, and all those who have an important part in these transactions must undertake the huge job ahead with the fixed determination that no obstacle of tradition or conservatism shall be allowed to interfere with the full sweep of a proper program.

Features of 90,000-Hp. Hydro-Electric Station on Wateree River









No. 1—Downstream view of Wateree dam and power station.

No. 2—Interior view of Wateree power station showing five 14,000-kva. generators.

No. 3—Power house substructure showing wheel chamber forms in course of construction.

No. 4—Power house substructure showing draft tube forms in course of construction.

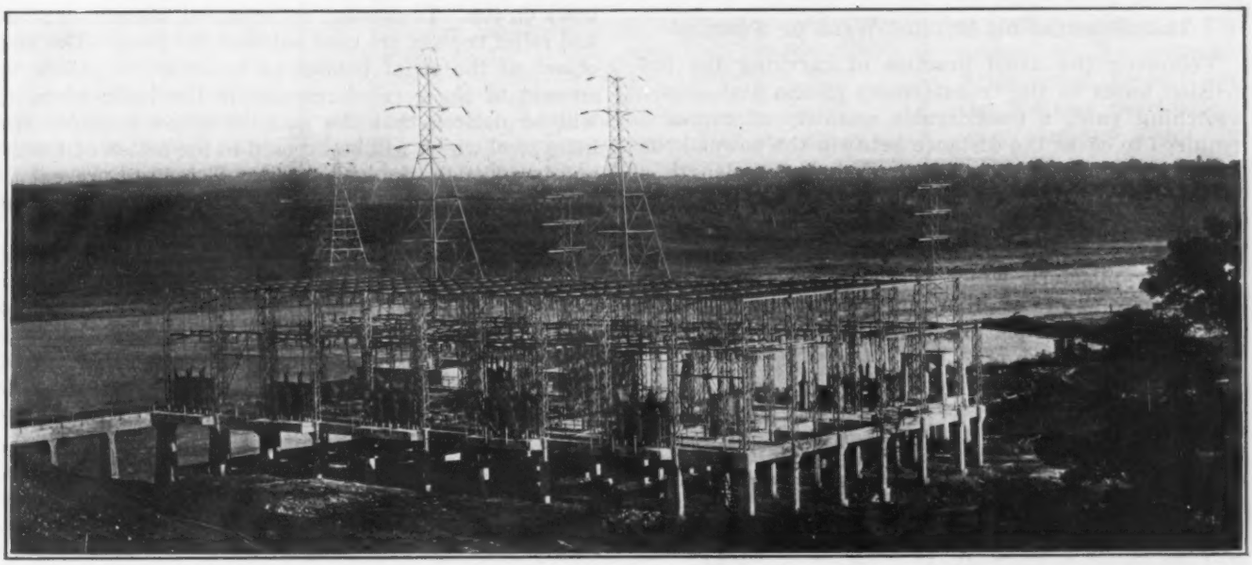
No. 5—View of east end of power house showing transformer platforms on downstream wall.

No. 6—View along upstream face of rack structure to turbines.

The Southern Power Company's Largest Station

On Wateree River Above Camden, S. C., the Southern Power Company Has Built a 90,000-Hp. Generating Station and Outdoor Switching Station—The Designs of Both Provide for Operation Under Extreme Conditions of Sudden Floods of Large Magnitude

By W. S. LEE[1] and RICHARD PFAEHLER[2]



OUTDOOR SWITCHING STATION SUPPORTED ON CONCRETE SUBSTRUCTURE SO THAT TRANSFORMERS ARE MOUNTED ABOVE HIGH-WATER LEVEL

THE LARGEST of the eight hydro-electric stations of the Southern Power Company, having a combined rating of 244,400 kva., is situated on the Wateree River, 8 miles (12.8 km.) above Camden, S. C. This stream, which is known as the Catawba River above the mouth of Wateree Creek, has a drainage area of 5,010 square miles (127,750 hectares) at the station. By the construction of a masonry spillway, masonry bulkhead and earth-fill extension on the west side of the river, a reservoir has been created which covers an area of 11,500 acres (4,600 hectares) when full. The Wateree plant was started on Oct. 7, 1919, and the first water was flowing over the spillway on Dec. 22, 1919.

It is generally known that the Catawba River is subject to sudden floods of large magnitude. The most severe high water of record occurred on July 18, 1916, when, according to the estimates, the Wateree River carried 425,000 cu.ft. (12,300 cu.m.) per second. At that time, which was four months before construction work was commenced, the river rose 35 ft. (10.6 m.) above the normal water level at the spillway site. Considering these extreme conditions, the power-house floor was built at elevation 189.0, which is 49 ft. (14.9 m.) above the mean tailwater level, and the bottom of the basement openings at elevation 179.3, or 2.3 ft. (0.7 m.) above the recorded extreme high-water level. The basement openings, large enough for the passage of the ventilating air for the generators, are provided with pivoted steel sash covered with wire-mesh glass.

[1]Vice-president and chief engineer Southern Power Company.
[2]Hydraulic engineer.

The ogee spillway of 1,450 ft. (442 m.) length and 74 ft. (22.5 m.) average height across the river bed is of the gravity type and built of concrete masonry. It is designed for a height of water of 18 ft. (5.4 m.) above the crest line and for an uplift at the base, decreasing in a parabolic function from full hydrostatic pressure at the heel to zero at the toe. The effect of silt pressure due to sedimentation of the reservoir to 28 ft. (6 m.) below the spillway crest is also considered. The top of the power-house bulkhead is 30 ft. (9 m.) above the spillway crest level, and assuming that the high water should reach this height, it is estimated that the discharge over the spillway would exceed the record flood of July 18, 1916, by more than 100 per cent. Considering this extreme case, which is never likely to happen, the analysis shows that the factor of safety against sliding at the base of the spillway is still above unity, disregarding any backwater effect against the downstream face of the structure.

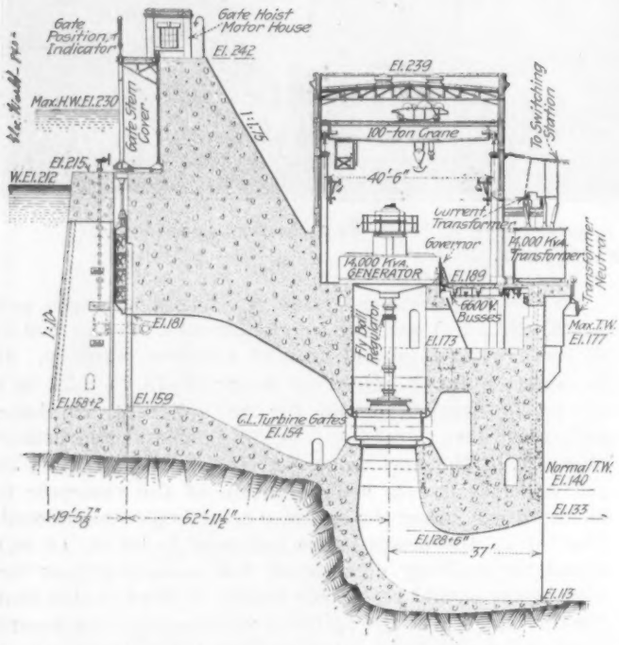
Power-House Construction

The power-house substructure forming the downstream extension of the bulkhead is built of concrete masonry. It is strengthened by reinforcing steel around the five wheel chambers which are formed in the concrete, and in the design of the structure a high-water level is used which is 30 ft. (9 m.) above the spillway crest. The draft tubes are also formed in the concrete, and only the upper portion is lined with plate steel so as to prevent wearing of the concrete surfaces due to high velocities of the water when the turbines are operated at full load.

Under extreme high-water conditions the resultant forces transmitted through the substructure will be very large, and a rich concrete mixture is therefore used around the draft tubes so as to keep the internal stresses within safe limits. The entire power-house bulkhead and substructure is built on excellent bedrock. The generator-floor system is built of reinforced concrete designed to carry a load of 800 lb. per sq.ft. (3,904 kg. per sq.m.) between the generators and of 650 lb. per sq.ft. (3,172 kg. per sq.m.) elsewhere.

Transformers on Outside Wall of Station

Following the usual practice of carrying the low-tension buses to the transformers in the high-tension switching yard, a considerable quantity of copper is required to cover the distance between the power house and the outdoor station. To cut down the length of low-tension wiring to a minimum in this large plant, the five three-phase transformers, of 14,000-kva. capacity each, are placed on reinforced-concrete platforms supported by pilasters, which are cast together with the downstream wall of the power-house substructure. Embedded in these platforms are the transformer rails,



SECTIONS THROUGH BULKHEAD AND POWER HOUSE OF WATEREE STATION

which extend into the interior of the power house. By means of sheave blocks and cable affording suitable connection of the transformer carriage with the 100-ton power-house crane each transformer may be rolled into the interior of the station for further handling. The weight of each transformer filled with oil is 107,500 lb. (48,375 kg.).

The power-house superstructure is built of red brick which incases the structural steel frame supporting the roof trusses and the runways for the 100-ton electric crane. The windowsills and lintels are of concrete, and the roofing is a Barrett specification roof laid on cement tile.

Each turbine intake has one 12-ft. x 22-ft. (3.6-m. x 6.7-m.) and one 18-ft. x 22 ft. (5.4-m. x 6.7-m.) entrance opening, giving a wetted area of 660 sq.ft. (60.7 sq.m.). Since the bottom of each opening is 53 ft. (16.1 m.) below the spillway crest level, considerable water pressure will be exerted against the rack surface, assuming that the racks are entirely clogged up. To decrease the unsupported length of the horizontal steel beams to which the rack bars are attached, 18-in. (4.6-cm.) thick reinforced-concrete baffle piers are built between the masonry piers extending from the upstream face of the bulkhead. These baffle piers have a height of 45 ft. (13.7 m.) and are well anchored to the masonry base at the bottom and to the 12-ft. (3.6-m.) high masonry block on top. To prevent deformation, horizontal struts and relief trusses are used between the piers. The main object of the relief trusses is, however, to reduce the amount of shear reinforcement in the baffle piers. It will be noticed that the rack structure contains very little steel which will be exposed to the action of the air, and in addition, the baffle piers will tend to prevent the formation of eddies between the racks and the headgate openings.

Vertical Shaft Turbines

The five turbines installed in the power house are of the Francis vertical-shaft, single-runner, concrete-spiral-casing type, operating at a speed of 100 r.p.m. The range in head on these waterwheels is between 55 ft. and 75 ft. (16.7 m. and 22.8 m.), and within these limits the rating of each unit is as follows:

	Minimum	Normal	Rated	Maximum
Head in feet	55	63	68	75
Normal horsepower	11,700	14,200	15,800	18,000
Maximum horsepower	13,000	15,750	17,500	20,000

The individual governor system is interconnected, and the rotary oil pumps, pressure tanks and receiving tanks are installed in the power-house basement. Each governor is adjusted to close the turbine gates in three seconds, and the guaranteed speed regulations, based on a flywheel effect of 9,000,000 lb.-ft. (1,340,000 kg.-m.) squared and any head from 68 ft. to 75 ft. (20.7 m. to 22.8 m.) are:

For Sudden Load Changes (in Hp.) Of	Load Increase Speed Drop, in Per Cent	Load Decrease Speed Rise, in Per Cent
17,500	..	35
12,000	28	23
6,000	12	11
2,000	4	3.5
500	1	1

Five 6,600-volt, 60-cycle, three-phase vertical-shaft Allis-Chalmers generators are directly connected with their respective turbines. Each unit is designed for a normal output of 14,000 kva., and when operating continuously at the rated load and 80 per cent power factor the increase in temperature is guaranteed not to exceed 40 deg. C. in any part of the alternator. A Kingsbury thrust bearing is provided on top of each generator. The individual exciters placed above the thrust bearings have a normal rating of 140 kw. at 250 volts and 100 r.p.m.

A central automatic oiling, filtering and cooling system, capable of furnishing continuously 20 gal. (7.5 l.) of oil per minute for each generator, is installed in the plant.

The tailrace is 2,700 ft. (822 m.) long and is designed for a flow of water of 11,000 cu.ft. (308 cu.m.) per second. In this distance the river has a fall of 3.5 ft. (1.05 m.), and deducting an estimated loss of head of 0.8 ft. (0.24 m.) in the tailrace due to friction, a net

gain in head of 2.7 ft. (0.81 m.) is obtained by extending the tailrace beyond the shoals immediately below the spillway. The outdoor switching station is connected with the power house by a reinforced-concrete footbridge, in which the conduits containing the electric control circuits for the high-tension oil circuit breakers are embedded. Along the river edge a low retaining wall going down to bedrock is built. The first row of columns supporting the reinforced-concrete deck is anchored into this retaining wall, and the bases for all the other columns rest upon disintegrated rock or clay foundations. The top of the reinforced-concrete slabs, upon which the electric switching apparatus is placed, is level with the generator floor. The structural steelwork built to carry the high-tension wiring and the disconnecting switches is galvanized throughout.

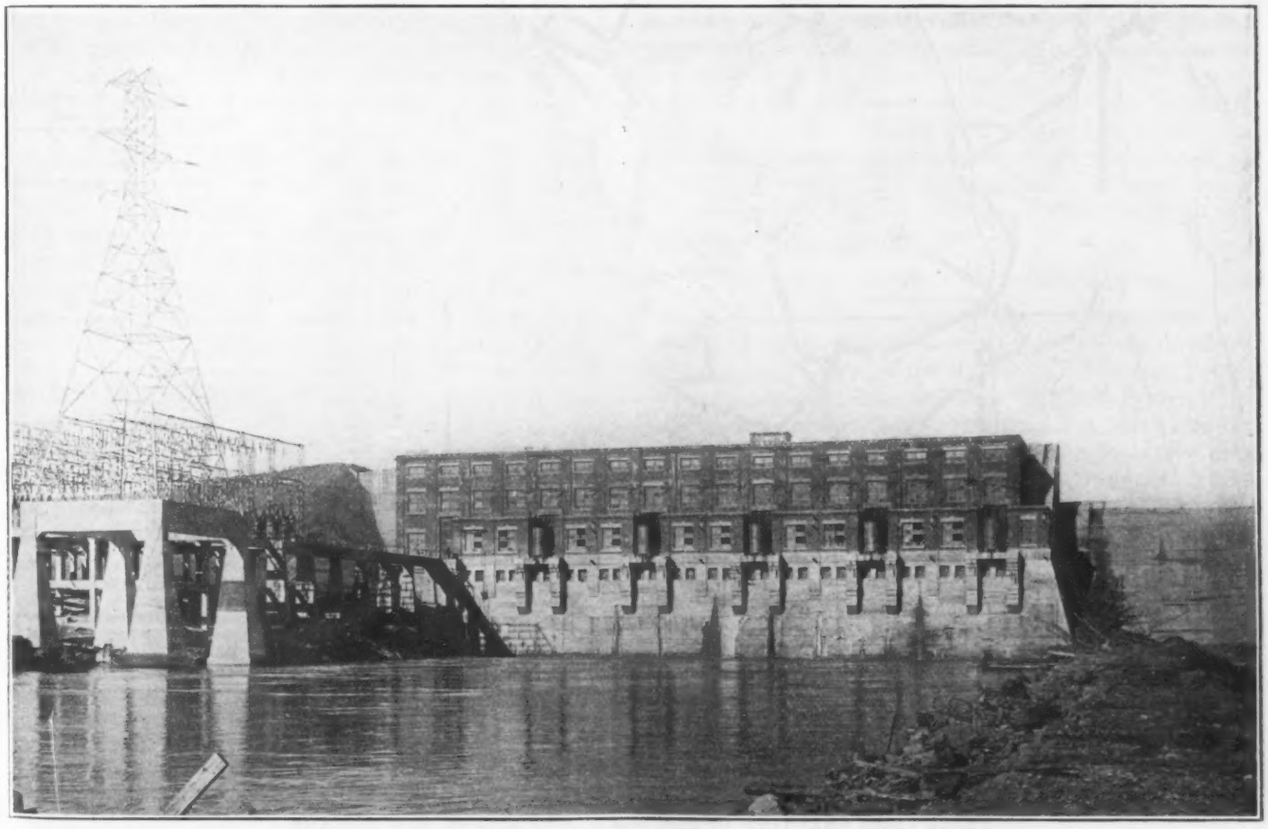
The high-tension lines crossing the Wateree River immediately below the spillway are carried by galvanized steel towers 123 ft. (37.4 m.) high, and on the west side, next to the outdoor switching station, the concrete bases supporting the towers have an average height of 42 ft. (12.8 m.) above the original ground line. The clear span between a pair of river crossing towers is 1,750 ft. (533 m.). The details of the complete Bridgewater project and the Wateree development were executed under the direction of W. S. Lee, vice-president and chief engineer of the Southern Power Company. On the Bridgewater work Albert S. Crane of the J. G. White Engineering Corporation was retained as consulting engineer in connection with the design and construction of the earth dams and masonry structures. F. H. Cothran was the resident engineer. On the Wateree work C. O. Lenz of New York City was retained as consulting engineer. C. I. Burkholder, general manager of the Southern Power Company, laid out the electrical features, and A. C. Lee was the resident engineer.

Supplements to This Issue of the "Electrical World"

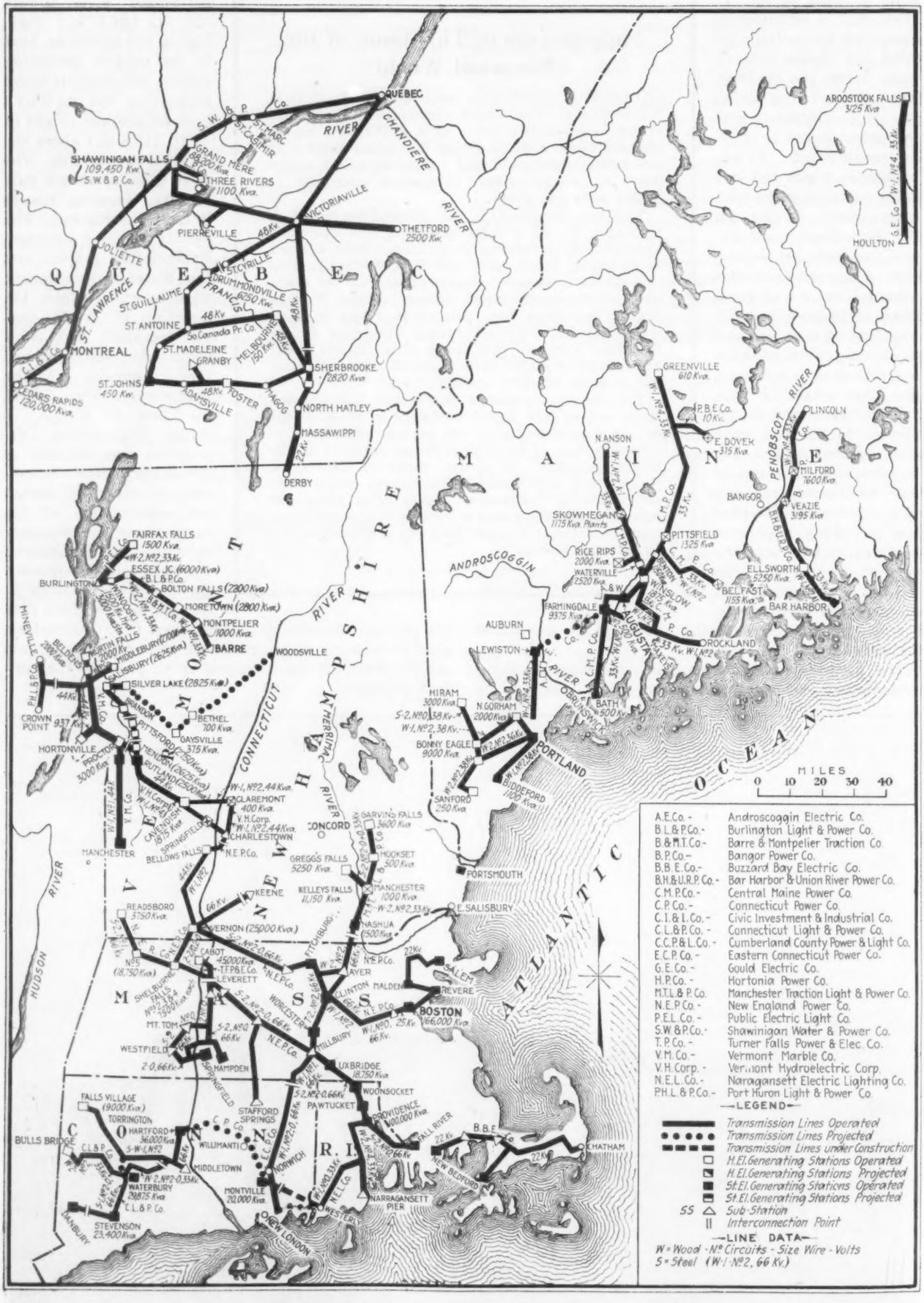
ACCOMPANYING this issue of the ELECTRICAL WORLD are two insert supplements, one a map of the transmission lines of the Western States and the other a chart giving the characteristics of generating, substation and transmission-line equipment of central-station companies operating at 44,000 volts and above.

The map supplements the information which is presented in the articles describing the operating and engineering features of the transmission systems in Montana, Washington and Oregon elsewhere in this number. In order clearly to indicate the trunk lines of the transmission systems of the Western States, they have been printed in colors to show their respective voltage ranges according to the following scheme: Blue, lines under 50,000 volts; green, lines of 50,000 volts to 99,000 volts inclusive; red, lines of 100,000 volts and over.

The chart supplements the section transmission maps and will be found useful as a guide to the design and construction of transmission lines in different parts of the United States operated at different voltages. It covers turbines, generators, step-up and step-down transformers, construction and operating features of transmission lines, and lightning protection, and brings up to date information contained in a chart formerly published in the ELECTRICAL WORLD.



DOWNSTREAM VIEW OF 90,000-HP. WATEREE STATION OF SOUTHERN POWER COMPANY



TRUNK LINES THAT LINK UP THE POWER RESOURCES OF NEW ENGLAND

Interconnection in New England

Movement Shows Steady Development During the Past Five Years, with Resulting Economic and Operating Advantages and Conservation of Fuel, Material and Capital—Interconnected Lines Between Five of the Six States

IN NEW ENGLAND the importance of fuel saving came to the front even before the United States entered the world war. The success of interconnections between adjoining systems of electrical supply led to a comprehensive development which is still in process and which will undoubtedly remain a permanent feature of public utility operation. The benefits of this policy are so great in peace that there is small chance of a reversion to the old days of electrical insularity.

As the accompanying map of the New England transmission systems shows, all states with the exception of Maine are now interconnected. Even in the Pine Tree State local systems are beginning to establish intertransmission lines. The exportation of energy from Maine is at present prohibited, but as time passes it is to be expected that public sentiment will change and permit the exportation of surplus hydro-electric energy at least. The benefits of interconnection elsewhere in New England are so great that it is unlikely that Maine will long be contented to suffer the economic disadvantages of the existing restrictive policy.

There are now so many interconnections in New England that space allows mention of only a few of the later arrangements for interchange of energy and some of the prospects of the immediate future. Last January service was inaugurated over the Boston Edison-New England Power transmission tie line, which interconnects the largest central-station company in New England with the largest hydro-electric power distributer, putting points remote in Vermont, southern New Hampshire, Connecticut and western Massachusetts in electrical touch with the largest tidewater steam plant in these states, and indirectly connecting the Providence and Fall River companies with Boston. This interconnection has been utilized to great advantage in assisting the New England company to handle its day load, while at night hydro-electric energy has been delivered to the Boston company to supplement the existing facilities of the latter and to save fuel.

The recent extension of the New England Power Company's transmission system into Nashua, N. H., and the previous interconnection of the Nashua central-station system with that of the Manchester Traction, Light & Power Company have brought about a tying together of plants in the Merrimack, Deerfield and Connecticut River valleys. The Montville steam plant of the Eastern Connecticut Power Company has lately been interconnected with the New England system through a new line to Millbury, Mass., the operating headquarters of the latter. The new Stevenson hydro-electric plant of the Connecticut Light & Power Company has been tied into the mid-state systems of the latter and of the Hartford Electric Light Company and the Connecticut Power Company. The Fall River Electric Light Company, in Massachusetts, is connected by a recently completed transmission line with the Narragansett Electric Lighting Company's steam plant at Providence, R. I., and through the Rhode Island Power Transmission Company and affiliated New England Power system with the Turners Falls Power & Electric Company's system. Through an outdoor switching station at Leverett, near Amherst, Mass., the New England and Turners Falls systems are interconnected, and this makes it convenient for the Turners Falls Company to deliver energy into the New England system at Leverett, the Fall River company taking energy from the New England and Providence lines in its own district and purchasing from the Turners Falls company through the above interconnections. The central stations at Worcester, Springfield and other central New England points continue to work effectively with the New England and Turners Falls companies respectively, on the interconnection basis.

In Vermont the development of the Vermont Hydro-Electric Corporation's system through interconnection and consolidation of various properties in the southern part of the State and in western New Hampshire is a recent instance of progress. Through this system, which maintains headquarters at Rutland, interconnection is maintained with the Hortonia Power Company and the Vermont Marble Company's hydro-electric plants in the Green Mountain district. Farther north the Burlington Light & Power Company is interconnected with the Barre & Montpelier Traction Company, and a recent tie-in has been effected with the plant of the Public Electric Light Company at Fairfax Falls.

There are many important interconnections operating in New England over lines carrying energy at below 33,000 volts, the approximate minimum shown on the accompanying map. The noted Salem-Malden-Revere line is now interconnected with the Boston Edison system, and a fair degree of electrical continuity exists in western Vermont. The general tendency is toward the establishment of interchange relations along lines of substantial energy-carrying capacity. Present practice avoids mere frontier contacts of systems which can be co-ordinated to advantage.

Important Interconnections Planned

In the near future an important interconnection will be built from the Hartford-Connecticut Power territory southeastward to tie in the Eastern Connecticut Power Company and its connected New England Power lines with western and central Connecticut. A line is under construction from Mystic, Conn., to the Montville station, and when this is completed the Narragansett plant at Providence, R. I., will be interconnected with the central and western Connecticut systems, and Boston as well. In Maine the construction of a transmission line between the Central Maine Power Company's system at Gardiner and the Androscoggin Electric Company's plants in the Lewiston-Auburn district will accomplish important operating improvements. It seems reasonable to expect in due time complete interconnection from Bangor, Me., through the Central Maine system and Androscoggin system to that of the Cumberland County Power & Light Company at Portland. The removal of power export prohibition in Maine would

clear the way for electrical continuity from northeastern to southwestern New England. In the near future it is planned to connect the western and eastern groups of lines operated by the Hortonia Power Company, in central Vermont. The Boston Edison system is now working southward to Quincy and beyond.

Interconnection with industrial plants has developed gradually in New England during the past decade. Many of the customers of the New England Power Company are equipped to deliver energy reciprocally to the hydro-electric system's lines, and a notable connection exists between the Cumberland County Power & Light Company of Portland, Me., and the system of the S. J. Warren Company. In the latter case the supply of energy to the central-station company by the Warren interests is largely by courtesy, but at times of service interruption and low water on the Cumberland system it has been most helpful.

Many further opportunities exist in New England for the development of interconnections. Aside from the Maine companies, several systems serving southwest Connecticut from tidewater steam plants on Long Island Sound have yet to cultivate interconnection to mutual advantage, and in northern New Hampshire a good deal remains to be done. The achievements already attained form in many cases a satisfactory groundwork for the larger trunk-line plans advocated nationally. The rapid growth of interconnection in Massachusetts is shown in an accompanying curve, which sets forth the total interchange of energy from year to year by Massachusetts central stations from 1913 to 1919, inclusive.

INTERCONNECTION CONSERVING FUEL IN MASSACHUSETTS

Interconnection between the electric supply systems of Massachusetts is silently effecting fuel economies little appreciated by the general public. The existing high prices of coal, the probability of their continuance for some time and the economic importance of saving fuel for the country overemphasize the value of intercompany lines as never before in times of peace. On three representative interconnected groups of electrical supply in the Bay State it is safe to say that at least 1,250 tons of coal per month are being saved in this way, representing on a conservative basis a saving of not far from $300 per day. Taking the State as a whole and bearing in mind that at present hydro-electric plants are running with wide-open gates, it may be estimated that the electrical utilities are saving at least 250 tons of coal a day as a result of the interconnection policy, and perhaps much more. It would not be unreasonable to assume that $750,000 worth of coal is now being saved annually by Massachusetts interconnections, and the direct bearing this has upon the holding down of rates from radical advances is evident.

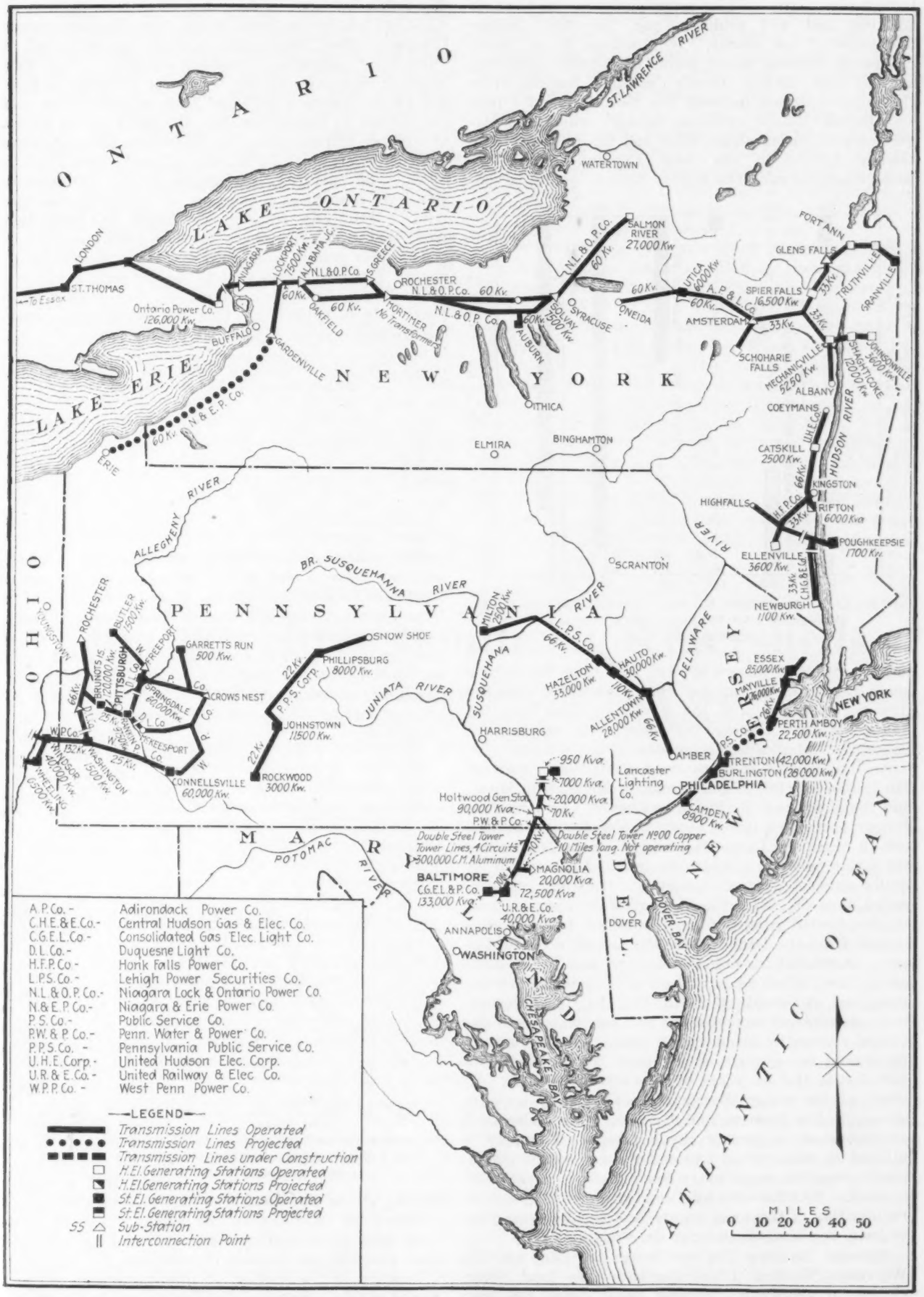
In the ELECTRICAL WORLD of May 17, 1919, page 1014, data were presented upon the interchange of energy among various Massachusetts stations, and it was estimated that in 1917 and 1918 the Salem-Malden-Revere tie line had saved the connected companies at least 8,550 tons of coal. In 1919 this line was operated even more advantageously. During the fiscal year the Salem company delivered 17,454,000 kw.-hr. to the Eastern Massachusetts Electric Company, owner and operator of the line, and purchased no energy therefrom. The energy was produced at the Salem tidewater station with a differential of at least 1.5 lb. (0.67 kg.) per kilowatt-hour in favor of Salem. The Malden and Revere companies purchased 15,853,193 kw.-hr. from the Eastern Massachusetts company, the Revere station not being operated during the year and the Malden station being run to produce but 4,052,100 kw.-hr.

This output at Malden required about 3.8 lb. (1.7 kg.) of coal per kilowatt-hour, while the Salem plant produced at 1.92 lb. (0.86 kg.). The energy purchased at Malden and Revere therefore represents a saving of about 10,600 tons for 1919 alone, making a total estimated saving of about 20,000 tons by this line in the

DETAILS OF TRUNK LINE SYSTEMS OF NEW ENGLAND AND EASTERN SEABOARD STATES

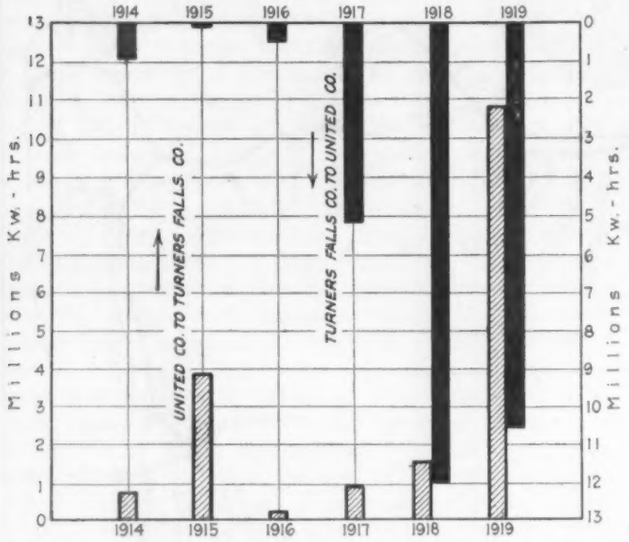
Companies	Territory Served	Service Wholesale or Distributed	Miles High-Tension Line and Voltage Mi.	Kv.	No.	Poles	High Tension Substations No.	Rating, Kva.
Androscoggin Electric Company	S. Me.	D	21	33	4	Wood	3	900
Bangor Railway & Elec. Inst'sts	E. Me.	D	66	33	4	Wood	9	16,725
			25	50	3			
Barre & Montpelier Traction Company	N. Vt.	D	22	33	1	Wood	2	3,750
Boston Edison Company	E. Mass.	DW	20	66	0		1	15,000
Burlington Light & Power Company	N. W. Vt.	D	36	33	1	Wood	1	3,000
Central Maine Power Company	Cent. Mass.	D	322	33	2	Wood	25	17,133
Connecticut Light and Power Company	S. W. Ct.	D	14	66		Wood Steel	4	42,875
Connecticut Power Company	W. Cent. Ct.	DW	70	66	1	Wood Steel	5	28,000
Cumberland County Power & Light Company	S. W. Me.	D	105	38	2	Wood	6	32,200
Eastern Connecticut Power Company	E. Ct.	DW	47	66	2/0	Wood		
Gould Electric Company	N. E. Me.	D	45	33	4	Wood	6	2,500
Hortonia Power Company	Cent. Vt.	DW	50	44	4	Wood		
Manchester Traction Light & Power Company	S. N. H.	D	40	33	2	Wood	6	24,340
Narragansett Electric Lighting Company	S. Ct. & P. I.	DW	83	33	0	Wood	8	8,375
New England Power Company	Cent. New Eng.	W	30	44	2	Wood		
			243	66	2/0	Steel	16	154,200
Public Electric Light Company	N. Vt.	D	19	33	2	Wood		
Turner Falls Power Company	W. Cent. Mass.	W	100	66	0	Steel	5	139,550
Vermont Hydroelectric Corporation	S. Cent. Vt.	D	70	44	2/4	Wood	5	10,000
Vermont Marble Company	W. Cent. Vt.	D	70	44	3		7	4,725
Adirondack Electric Power Corporation	E. N. Y.	DW	33	3/0				
			60	1/0		Steel	17	50,000
Duquesne Light Company	W. Pa. Pittsburgh	D		66		Wood Steel	160	210,000*
Niagara, Lockport & Ontario Power Company	N. N. Y.	W		33	Misc.‡			
				60	Misc.	Steel	5	39,000
Pennsylvania Water & Power Company	S. E. Pa.	W	80	70	150,000 Cu†			
			80	70	300,000 Al	Wood	2	92,500
Public Service Electric Company	N. J.	DW	925	26.4	500,000 Al	Wood		
			925	13.2	350,000 Cu	Steel	93	226,803*
Southern Canada Power Company	S. Ontario	DW	236			Wood Steel	21	13,800
West Penn Power Company	W. Pa.	DW	805			Steel	131	184,270*
			26		132			

*Includes all substations. †Cu, copper. Al, Aluminum. ‡Misc., miscellaneous sizes.



TRANSMISSION SYSTEMS WHICH SERVE LARGE EASTERN SEABOARD INDUSTRIAL CENTERS

last three years. This interconnection cost about $550,000 and will probably pay for itself within five years if not sooner. It functions as an interconnection between steam plants of different economy, and as yet derives merely nominal benefit from the interconnection between the New England Power and Boston Edison systems, through which the largest central-station steam plant and the largest hydro-electric system in the New England States are being co-ordinated. The Boston Edison system is connected with the Revere system, but thus far only a small amount of energy has been transmitted over the line in comparison with the service received from the Salem station. During the recent coal shortage at Salem this interconnection proved of much value.



INTERCHANGE OF ENERGY BETWEEN UNITED ELECTRIC LIGHT COMPANY AND TURNERS FALLS POWER & ELECTRIC COMPANY

An interconnection of no small worth exists between the United Electric Light Company, Springfield, Mass., and the Turners Falls Power & Electric Company. The former operates a mixed steam and hydro-electric system in which the steam-plant service predominates, and the latter operates a hydro-electric system with a recently completed steam auxiliary. In the six years ended June 30, 1919, the Turners Falls company sold to the United company 29,325,100 kw.-hr. and purchased from the latter 17,295,250 kw.-hr. The difference, 12,029,850 kw-hr., would have had to be made up by the United company had no interconnection existed, and, at the rate of 2.5 lb. (1.13 kg.) per kilowatt-hour, would have increased the fuel consumption of the United system by about 26,800 tons. It would not be far wrong to estimate a saving of from $150,000 to $200,000 in the six years by this interconnection. At times of low water the Springfield company supplies energy to the Turners Falls system, while under such conditions as at present the hydro-electric supply is utilized to great advantage and the amount of steam-plant operation required at Springfield is greatly decreased. Weather and load conditions cause great irregularities in the total energy interchange from year to year, as the accompanying diagram indicates.

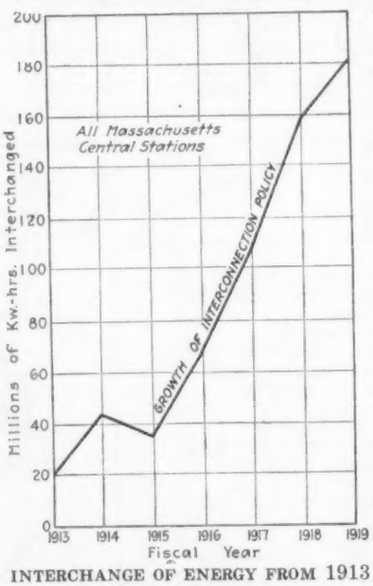
Between the New England Power Company and the Worcester Electric Light Company the total interchange of energy in the past seven years has been 67,113,384 kw.-hr. In this case there is a balance of 4,714,544 kw.-hr. in favor of the New England Power Company, the interchange having approximated a "fifty-fifty" operation, speaking roughly. The New England company sold the Worcester company 35,915,464 kw.-hr. between 1913 and 1919, and the latter sold the former 31,196,920 kw.-hr. On the basis of 2.5 lb. of coal per kilowatt-hour, the interconnection saved the Worcester company 5,260 tons of coal from 1913 to 1919. The operating advantages of the interconnection have enabled each company to handle its business with a relatively smaller investment in generating plant than would have been the case otherwise.

The table printed here gives the total interchange of energy between Massachusetts central-station systems (including hydro-electric companies) for the past seven years. It is noteworthy that the grand total interchange has reached 616,014,614 kw.-hr.

INTERCHANGE OF ENERGY BETWEEN MASSACHUSETTS CENTRAL STATIONS, 1913 TO 1919

Year	Kw.-hr. Interchanged
1913	20,046,708
1914	43,764,942
1915	36,711,926
1916	67,209,934
1917	109,085,946
1918	158,917,094
1919	180,278,064
Total	616,014,611

The number of interchange arrangements in effect, counting those of each pair of companies as one, varied from nine to seventeen during this period. It is of at least speculative interest to note that if each kilowatt-hour interchanged accomplished a saving of 1 lb. of coal, the total saving in fuel for the above period would be 275,000 tons, and that if a 1.5-lb. differential is allowed, the saving would be 412,000 tons. It should not be overlooked that in many of these interconnections very substantial gains in plant economy result immediately; for wherever hydro-electric energy does away with the need of generating by steam the gain is of the order of 1.5 lb. to 3 lb., and where a large steam plant is interconnected with a smaller one or with a group, it is frequently possible to realize gains of 1 lb. or 2 lb. It seems reasonable to believe that since 1912 interconnection in Massachusetts alone has saved more than a third of a million tons of coal and quite possibly half a million, looking at the facts with the utmost conservatism and omitting all reference to the supply of small plants from large centralized stations owned by interests which have absorbed the smaller installations.



INTERCHANGE OF ENERGY FROM 1913 TO 1919 BY MASSACHUSETTS CENTRAL STATIONS

Practice in the making of interconnection contracts varies widely. Some of the best operating results in

New England have been attained through agreements scarcely more than oral in character; and, on the other hand, contracts have been prepared and worked under during the past few years which have illustrated new and complex terminology and which have fitted conditions so intricate that few but specialists appreciate their structure and applications. Where the resale of energy is involved, with prorating of plant equipment to meet certain changes in load conditions, allocating to different corporations legal titles to apparatus and line segments, the agreements tend toward complexity. Comparatively little publicity has thus far accomplished the drafting of such contracts, and the work may in a sense be looked upon as in process of evolution. At present practice exhibits these two tendencies toward simplicity and toward complication, and it is perhaps too soon to say which school, if either, will predominate. At this writing not enough New England contracts of representative character are available to permit conclusions as to the best forms, and it will be necessary to leave the task of analyzing agreements of this class to a more favorable opportunity.

Since contractual relations vary widely, it follows that the prices of blocks of energy interchanged exhibit broad differences. A few instances may be cited from 1919 data. During the fiscal year the New England Power Company sold the Worcester Electric Light Company 2,623,200 kw.-hr. at an average price of $0.0035 (yield $9,181). It purchased from the Worcester Company 16,300,100 kw.-hr. at a unit price of $0.0102 (yield to Worcester company, $166,441). The arrangement was undoubtedly advantageous because of the ability of the Worcester company to absorb secondary power when available, and had the capacity not been available at the steam plant of the Worcester company, the New England company would have had to have made up its output elsewhere, and presumably at greater cost. It is quite inappropriate to judge the profitableness of any interconnection arrangement between two parties by comparing the unit prices of energy transferred in reverse directions.

The interchange of nearly equal blocks of energy in a given period of interconnection by no means results in nearly equal unit prices. Thus, the Turners Falls company sold the United company of Springfield 10,537,600 kw.-hr. in 1919 at an average unit price of $0.00679. From the United it received 10,846,100 kw.-hr. at $0.0084 per unit. The price at which one company can afford to sell energy to another is by no means necessarily the price at which it can afford to buy energy. The advantage for the time being may lie with the seller, or the class of power available may alter the conditions. Of the total energy delivered at its system buses in 1919—viz., 273,551,482 kw.-hr.—the New England Power Company purchased 158,307,730 kw.-hr. at an average price of $0.0062, and it sold to gas and electric companies 102,094,532 kw.-hr. at an average price of $0.0113.

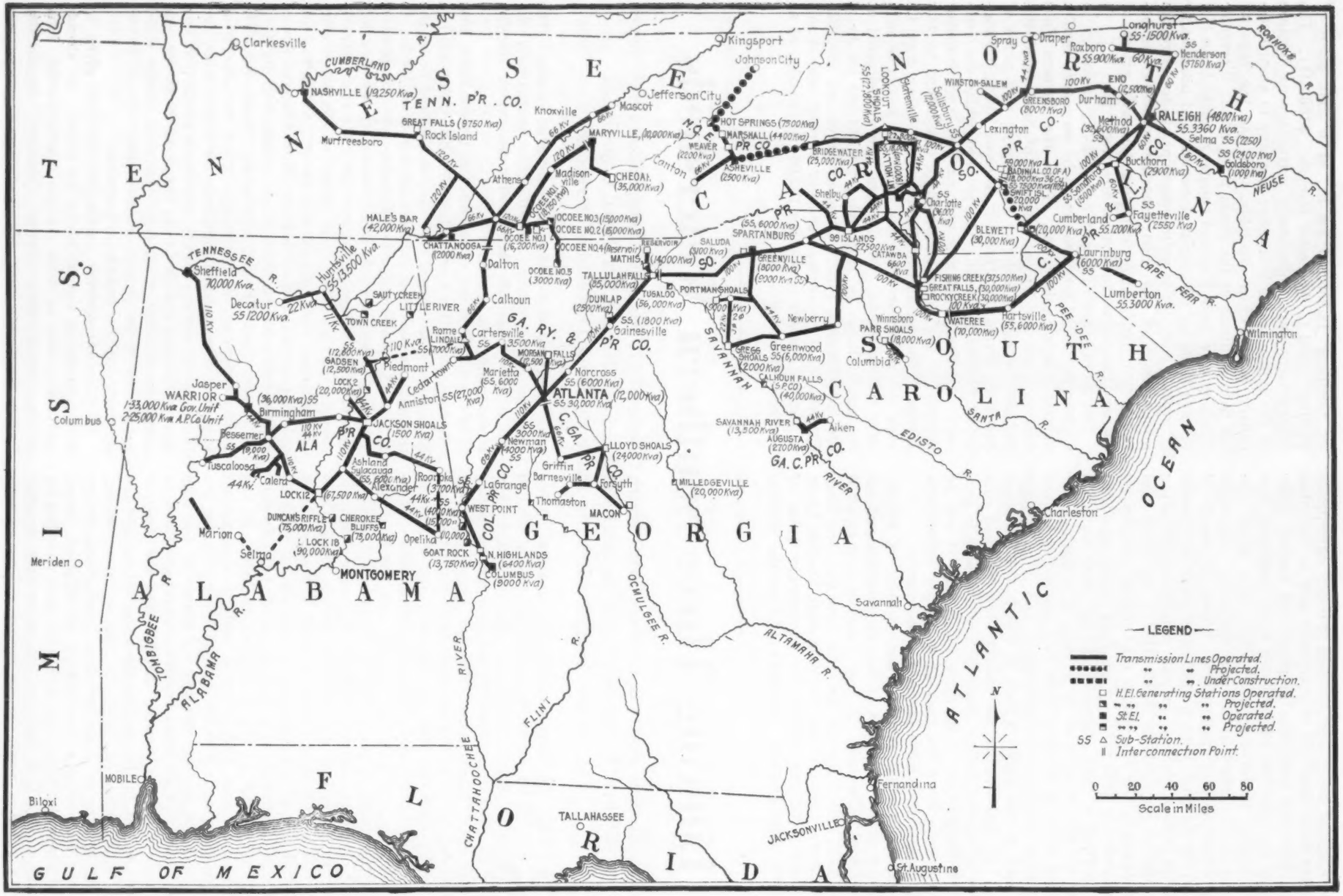
Linking Three Southern Watersheds

Twelve Electric Power Companies in the South Operate 7,114 Miles of Transmission Line—Seven of These Companies Are Now Interconnected and Have a Combined Capacity of 553,500 Kw. in Hydro-Electric Plants on Three Different Watersheds

SEVEN Southern operating companies having 553,500 kw. in hydro-electric plants and 186,050 kw. in steam stations—a total of 749,550 kw. in generating capacity—are now interconnected in one great transmission network extending from Henderson, N. C., in the northeast to Columbus, Ga., in the south, Sheffield, Ala., in the west and Nashville, Tenn., in the northwest. The companies whose transmission lines are thus tied together are the Southern Power Company, Alabama Power Company, Tennessee Power Company, Georgia Railway & Power Company, Columbus Power Company, Central Georgia Power Company and the Carolina Power & Light Company. The layout of this system, locations of generating stations, points of interconnection and proposed new developments are shown on the accompanying map. In the operation of these hydro-electric systems a maximum use has been made possible in thus tying together the powers of the various streams. A glance at the map shows that there are three distinct watersheds—first, in the eastern section, flowing directly into the Atlantic Ocean; second, in the southern section, flowing into the Gulf of Mexico, and, third, in the northern section, flowing by way of Tennessee and Cumberland Rivers into the Mississippi. The rainfall on different rivers, and at times at different points on the same river, varies in such a way that high or low water may severely affect a group of plants on one stream and not so seriously interfere with operation of those on another. The interchange of power, therefore, is particularly desirable and materially lowers the amount of standby steam equipment required.

Of the 4,719.4 miles (7,590 km.) of transmission lines which make up this system 1,659.6 miles (2,670 km.), a little more than 35 per cent, are steel-tower lines, the transmission voltages carried ranging from 44 kv. to 110 kv. Substations for transmission and distribution, excluding those for individual consumers, number 327 and have a combined capacity of 1,079,435 kva. in transformers. In 1919 the total output of the seven companies named was 1,821,821,089 kw.-hr., which was distributed in the following manner: For industrial power, 87 per cent; for residential and commercial lighting, 5.5 per cent, and for electric railways, 7.5 per cent. The rapid development of the South into a manufacturing section embracing such industries as textile mills, fertilizer works, cement plants, aluminum production, coal and iron mining and steel mills has given the power companies an excellent market for electrical energy which is reflected in the proportion of the total output, *i.e.*, 87 per cent, sold for industrial purposes.

In the accompanying tabulation data are given on twelve operating companies in the South. As already mentioned, seven of these are now interconnected. Four others, the Virginia Power Company, Appalachian Power Company, Parr Shoals Power Company and



HOW TRANSMISSION SYSTEM OF SOUTH LINKS TOGETHER THE DIFFERENT WATERSHEDS

Augusta-Aiken Railway & Electric Company, could easily be tied into the same great system. The Texas Power & Light Company, not so geographically situated as to become a part of this transmission system, operates six steam stations through interconnection of 1,334 miles (2,140 km.) of transmission line.

The principal features of the twelve systems, including the extensions and developments which have been made, are outlined in the following paragraphs referring to each company:

Southern Power Company.—Besides being the pioneer transmission company in the South, the Southern Power Company operates the most extensive system. In the States of North and South Carolina 2,050 miles (3,290 km.) of transmission line have been built, with eight hydro-electric and four steam stations. The ratings of the eight hydro-electric stations are as follows: Great Falls, S. C., 30,000 kva; Rock Creek, S. C., 30,000 kva.; Fishing Creek, S. C., 37,500 kva.; Wateree, S. C., 70,000 kva.; Catawba, S. C., 6,600 kva.; Ninety-nine Islands, N. C., 22,500 kva.; Lookout Shoals, N. C., 22,800 kva., and Bridgewater, N. C., 25,000 kva. The aggregate capacity of these plants is 244,400 kva. The Great Falls, Rocky Creek, Catawba and Ninety-nine Islands stations were placed in operation prior to 1915, while the plant at Lookout Shoals was completed and operation started in 1915, the one at Fishing Creek in 1916 and those at Bridgewater and Wateree in 1919. Steam plants of 8,000 kva. each are operated at Greenville, S. C., Greensboro, N. C., and Mount Holly, N. C., and one of 12,500 kva. is at Eno, N. C. The total rating of the steam plants is 36,500 kva. and the combined rating of hydro-electric and steam stations, 280,900 kva. The increase in load for 1919 was 33,900 kw. and the total output for the year was 585,596,925 kw.-hr., of which 80 per cent was used by textile mills, 10 per cent by miscellaneous industries and 10 per cent by lighting and railways. Of the 2,050 miles of transmission line 780 miles (1,256 km.) are steel-tower lines of 44,000 and 100,000 volts. There are 201 substations connected to the lines with a total rating in transformers of 443,500 kw. In addition, the above company controls the Southern Public Utilities Company, which operates plants on the Savannah and Seneca Rivers with steam plants at various points. The lines of the Southern Power Company tie in with the lines of the Georgia Railway & Power Company at Tallulah Falls, Ga.

Carolina Power & Light Company.—In eastern North Carolina the Carolina Power & Light Company operates 236 miles (379 km.) of transmission line from a hydro-electric plant of 2,900 kva. at Buckhorn Falls on the Cape Fear River, and steam plants of 4,800 kva. at Raleigh, 1,500 kva. at Gallsboro and 3,750 kva. at Henderson. This company also controls the Yadkin River Power Company, which has a hydro-electric plant of 30,000 kva. at Blewett Falls on the Yadkin River. Connected to the transmission system of the Carolina Power & Light Company are forty-nine substations having an aggregate rating of 69,910 kva. in transformers. The combined output of the two systems in 1919 was 55,620,870 kw.-hr. This system is tied in with the Southern Power Company at Durham, N. C.

Tennessee Power Company.—In Tennessee this company operates 544 miles (875 km.) of transmission line served by two hydro-electric stations on the Ocoee River; one of 18,750 kw. operated under a 110-ft. (33-m.) head and one of 15,000 kw. under a 255-ft. (76-m.) head, and also plants of 9,750 kw. under a 110-ft. head at Great Falls and 42,000 kw. under a 34-ft. (10-m.) head on the Tennessee River at Hales Bar. Four steam stations having a total rating of 36,000 kw. are operated at Parksville, Nashville, Knoxville and Chattanooga. The combined capacity of the hydro-electric and steam plants is 121,500 kw. The hydro-electric plant on the Tennessee River at Hales Bar is operated by the Chattanooga & Tennessee Power Company, which sells practically its entire output to the Tennessee Power Company. Of the total output of all stations in 1919—422,272,590 kw.-hr.—236,459,200 kw.-hr. was generated at the Hales Bar station. There are 339.12 miles (545 km.) of steel-tower lines in operation at voltages of 44,000, 66,000 and 120,000, and 179.26 miles (288 km.) of 66,000 volt line on wood poles. Connected to this system are twenty-five substations totaling 113,500 kva. in transformers. This company's lines are interconnected with the Georgia Railway & Power Company at the Georgia-Tennessee State line.

Georgia Railway & Power Company.—The system of this company covers northern Georgia and consists of 352 miles (566 km.) of transmission line with hydro-electric plants of 72,000 kw. at Tallulah Falls, 10,500 kw. at Morgan Falls, 2,200 kw. at Dunlap, and two steam stations in Atlanta totaling 21,500 kw. Additional development of the water power this year will add 16,500 kw. to the hydro-electric stations and make the combined hydro and steam generating capacity of the system 122,700 kw. This company estimates its undeveloped water-power resources at 274,000 kw. In 1919 the total current used on this system (generated and purchased) was 262,834,541 kw.-hr. There are 198.6 miles (319 km.) of 110,000-volt transmission line on steel towers. Wood-pole lines are operated as follows: 61.8 miles (99 km.) at 66,000 volts, 9 miles (14 km.) at 38,000 volts, 63.7 miles (101 km.) at 22,000 volts and 19.78 miles (31 km.)

PRINCIPAL FEATURES OF TWELVE SOUTHERN TRANSMISSION SYSTEMS.

Company	Capacity of Generators			Substations		Miles of Transmission Line	Yearly Output (Kw.-hr.)	Character of Load, per cent.		
	Hydro. Kw.	Steam (KW.)	Total (KW.)	No.	Total Kva. of Transformers			Residential and Commercial	Industrial	Electric Railway
Southern Power Company*	244,400	36,500	280,900	201	443,500	2,050	585,596,925	10.	80.	10.
Alabama Power Company*	69,500	70,500	140,000	9	274,100	1,051	347,993,284	.....	92.8	7.2
Tennessee Power Company	85,500	36,000	121,500	25	113,500	544.2	422,272,590	.....	.....	.....
Georgia Railway & Power Company	84,700	21,500	106,200	31	135,425	352.	262,834,541	.....	.....	.....
Texas Power & Light Company	.....	60,000	65,000	105	77,338	1,334.	217,775,493	18.3	61.3	20.4
Virginian Power Company	.....	49,000	49,000	73	54,875	347.3	69,658,650	.....	85.5	14.5
Appalachian Power Company	22,900	21,500	44,400	10	78,250	630.	124,095,511	3.	96.	1.
Carolina Power & Light Company*	32,900	10,050	42,950	49	69,910	236.	55,620,870	11.	87.	2.
Columbus Power Company	18,500	9,000	27,500	3	11,750	144.7	82,965,820	3.	94.7	2.3
Parr Shoals Power Company*	20,500	5,500	26,000	2	21,000	58.	52,642,090	8.	83.	9.
Central Georgia Power Company	18,000	3,000	21,000	9	31,350	231.5	63,518,965	9.4	82.6	8.
Augusta-Aiken Railway & Electric Company*	14,575	2,750	17,325	4	12,000	36.	40,000,000	.....	85.	15.
Total, all companies	611,475	329,800	941,775	521	1,322,998	7,114.7	2,324,992,739	8.2	84.2	7.6

*Ratings of generating stations and substations given in kva.

at 11,000 volts. There are twenty-one substations connected to the system having a total rated capacity of 135,425 kva. in transformers.

This company's transmission lines connect with the Central Georgia Power Company at Atlanta, the Tennessee Power Company at the Tennessee-Georgia State line, the Southern Power Company at Tallulah Falls, the Columbus Power Company at Newnan. A connection is also proposed with the Alabama Power Company at Lindale.

Central Georgia Power Company.—Returning to Georgia, the Central Georgia Power Company operates 231 miles (371 km.) of transmission line with one hydro-electric plant of 18,000 kw. from a 103 ft. (30-m.) head on the Ocmulgee River and two steam stations of 1,500 kw. each. The total output of the stations in 1919 was 63,518,965 kw.-hr., distributed as follows: Residential, 9.4 per cent; industrial, 82.6 per cent, and electric railways, 8 per cent. Transmission voltage throughout the system is 66,000 volts, and there are 97.5 miles (156 km.) of steel-tower and 36.5 miles (58 km.) of wood-pole lines in operation. Connected to the transmission system are nine substations having a total rated capacity of 31,350 kw. in transformers. At Atlanta the transmission lines of this company are tied in with those of the Georgia Railway & Power Company.

Columbus Power Company.—This company serves a large cotton mill load in and around the city of Columbus, Ga. It operates 144 miles (231 km.) of transmission line from three hydro-electric plants on the Chattahoochee River—one of 1,000 kw. from a 10-ft. (3-m.) head, one of 6,500 kw. from a 40-ft. (12-m.) head, and one of 11,000 kw. from a 70-ft. (21-m.) head—with a steam station of 9,000 kw. at Columbus. The combined hydro-electric and steam capacity of the system is 27,500 kw. The total output of the stations in 1919 was 82,965,820 kw.-hr., distributed as follows: Residential, 3 per cent; industrial, 94.7 per cent, and electric railways, 2.3 per cent. Sixty miles (96 km.) of the transmission line is on steel towers, 66,000 volts and 84.7 miles (135 km.) is on wood poles, 11,000 volts. There are three substations connected to the system, having an aggregate of 11,750 kw. in transformers. The transmission lines of this company are tied in with those of the Georgia Railway & Power Company at Newnan, Ga.

Parr Shoals Power Company.—This company sells its output to the Columbia (S. C.) Railway, Gas & Electric Company. It operates 58 miles (93 km.) of transmission line and a 35-ft. (10.5-m.) head hydro-electric plant of 15,500 kva. at Parr Shoals, S. C. In 1919 the total output was 52,642,090 kw.-hr., distributed as follows: Residential, 8 per cent; industrial, 83 per cent, and electric railways, 9 per cent. There are 44 miles (70 km.) of steel-tower and 14 miles (22.5 km.) of wood-pole transmission lines operated at 66,000 and 13,200 volts. Two substations having a total rating in transformers of 21,000 kva. are connected to the system.

Appalachian Power Company.—In the southern section of West Virginia and across the border into Virginia this company operates 630 miles of transmission line served by two hydro-electric plants, one of 16,000 kw. from a 50-ft. (15-m.) head and the other of 6,900 kw. from a 38-ft. (11-m.) head, and steam stations of 2,000 kw. at Clinchfield, 4,500 kw. at Roanoke and 15,000 kw. at Glenlyn. The combined capacity of the hydro-electric and steam stations is 44,400 kw., which will be increased to 64,400 kw. by the addition of a 20,000-kw. unit now being installed at the Glenlyn station. In 1919 the total output was 124,095,511 kw.-hr., distributed as follows: Residential and commercial, 3 per cent; industrial, 96 per cent; electric railways, 1 per cent. All transmission lines are on wood poles and are operated at 88,000 and 13,000 volts. There are ten large substations having a total rating of 78,250 kva. in transformers. This company has an arrangement with the Norfolk & Western Railroad for an interchange of power through a frequency changer up to a maximum load of 7,000 kw. It sells energy to the Rodford (Va.) Water Power Company and the Roanoke Railway & Electric Company.

Virginian Power Company.—In the coal fields of Central West Virginia this company operates 347 miles (558 km.) of transmission line from a steam station of 49,000 kw. at Cabin Creek Junction, W. Va. The total output for 1919 was 69,658,650 kw.-hr., distributed as follows: Industrial, 85.5 per cent, and electric railways, 14.5 per cent. There are 253.52 miles (408 km.) of steel-tower and 102.22 miles (164 km.) of wood-pole transmission line in operation. This company expects to construct during 1920 42 miles (67.5 km.) of 44,000-volt and 38 miles (61 km.) of 66,000-volt steel-tower lines. It will also install eleven new substations, which will make a total of eighty-four substations having an aggregate capacity of 54,875 kw. in transformers.

The Augusta-Aiken Railway & Electric Company.—In and around Augusta, Ga., this company operates 28 miles (45 km.) of transmission line and two hydro-electric stations, one of 13,500 kva. from a 30-ft. (10-m.) head at Stevens Creek and one of 1,475 kw. (direct current) from a 27-ft. (8-m.) head on a canal in Augusta. It also has a reserve steam plant of 2,750 kw. In 1919 the total output was 40,000,000 kw.-hr., distributed as follows: Residential and industrial, 85 per cent; electric railways, 15 per cent. There are 8 miles (2.4 m.) of steel-tower and 20 miles (6 m.) of wood-pole transmission lines operated at 44,000 volts. Four substations having a total rating of 12,000 kva. in transformers are connected to the system.

Alabama Power Company.—During the past eight years an extensive transmission network has been built which covers the greater portion of the central and northern sections of the State of Alabama. This system includes 1,051 miles (1,690 km.) of high-tension lines served by two hydro-electric plants, one of 67,500 kva. from a 68-ft. (20-m.) head at Lock 12 on the Coosa River and another of 2,000 kva. from a 26-ft. (7.8-m.) head at Jackson Shoals. Two large steam stations are also operated, one at Warrior of 58,000 kva. and the other at Gadsden of 12,500 kva. The combined capacity of hydro-electric and steam stations is 140,000 kva. In 1919 the total output of the stations was 347,993,284 kw.-hr., of which 92.8 per cent was sold for industrial purposes and 7.2 per cent used by electric railways. This company has 185 miles of steel-tower and 484 miles of wood-pole transmission lines operated at 110,000 and 44,000 volts. There are nine substations connected to the transmission system having a total rating of 274,100 kva. in transformers. An interconnection of this company's lines is proposed with those of the Georgia Railway & Power Company at Lindale, Ga.

Southwestern Power & Light Company.—In the Southwest this company controls a group of properties which operate together 1,334 miles (2,140 km.) of transmission lines from four stations of the Texas

Power & Light Company of 23,000 kw., one station of the Fort Worth (Tex.) Power & Light Company of 25,000 kw., and one station of the Dallas (Tex.) Power & Light Company of 17,000 kw. All of these are steam stations and their total capacity is 65,000 kw. In 1919 the combined output was 217,775,493 kw.-hr., distributed as follows: Residential, 8.1 per cent; industrial, 61.3 per cent; electric railways, 20.4 per cent; commercial, 10.2 per cent. The increase in load in 1917 was 18.4 per cent. This company operates 211.62 miles (340 kw.) of steel-tower transmission line at 60,000 volts. There are 105 substations connected to the system having a total rated capacity of 77,338 kva. in transformers.

Interchange of Energy in Middle West

Interconnection Shown to Be a Financial Help—Rates at Which Energy Is Exchanged Between Steam and Hydro-Electric Plants Vary

THROUGH the co-operation of the central-station companies concerned, the accompanying maps of Middle Western States have been prepared to show the extent and the possibilities of interconnection in that territory. In this instance interconnection is taken to mean not only the physical connection between different transmission systems but also the consolidation of many small properties into one system and the interchange of energy between central stations and their large customers. Both the 25-cycle and the 60-cycle light and power systems are shown, as are also the 25-cycle traction systems which dispose of a large portion of their service for light and power purposes. Essentially traction systems with 25-cycle transmission, such as those of the Ohio Electric Railway Company and the Union Traction Company of Indiana, and a number of branch lines, have been omitted to reduce the detail. For further data regarding the details of operating voltage, plant capacity, etc., reference may be had to the table. In addition to these transmission maps and table, typical daily load curves are presented showing a comparison of operating conditions for a number of systems of both eastern and western companies.

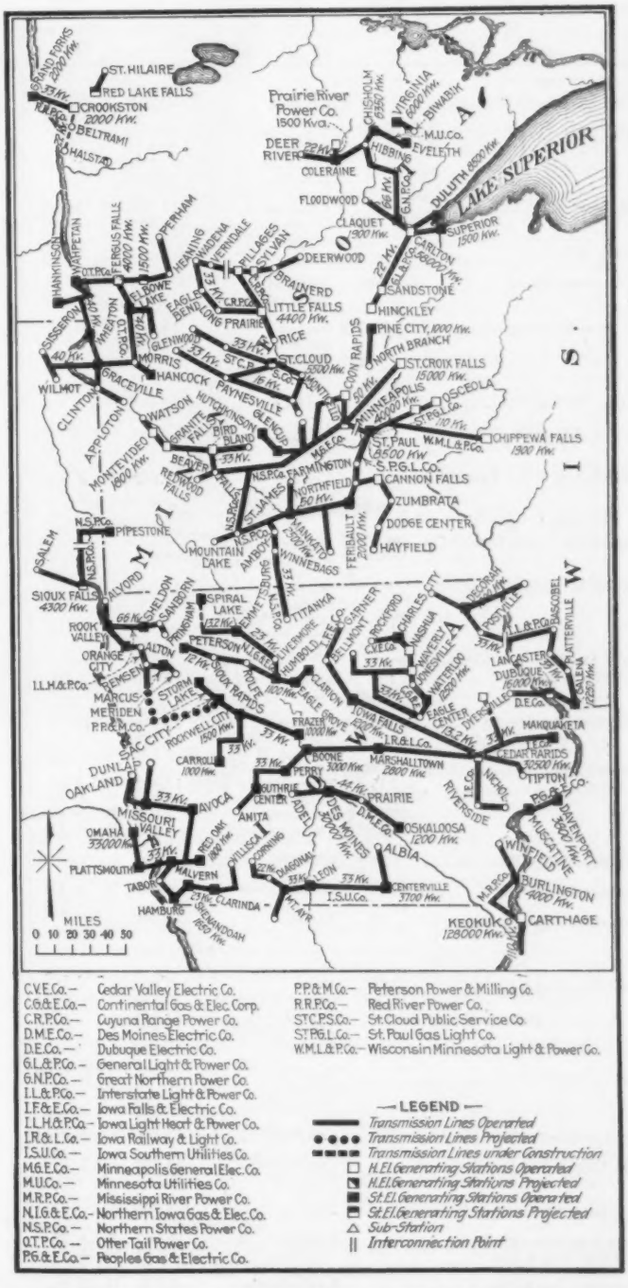
It seems to be the aim of the utilities in this section to shut down small or uneconomical plants whenever the cost of operating such power stations is materially greater than the increased cost of operating larger stations at the increased load. Through these savings and those which have been made possible by improved load factor and greater diversity factor industries have been supplied with energy at a lower rate than would otherwise have been possible. Interconnection has proved one of the most successful methods employed by the utilities to fight the rising cost of service to all their customers. Industrial consumers have also profited by the additional capacity and improved reliability of the service made available for their needs.

EXPENDITURES OF INTERCONNECTED CENTRAL STATIONS WILL BE REDUCED

The public-policy advantages of interconnection have been found to carry weight with financial men when the companies need funds. Increasing expenditures are being made for transmission lines and plants. However, managers of interconnected central stations say that their combined power-plant expenditures per kilowatt of customer's demand will be less than if they had continued to operate independently.

A demand and energy rate is used by practically all Middle Western companies in purchasing or exchanging energy, but the details vary widely. A guaranteed demand and minimum load factor is quite common, but some companies go one step further and contract for a specified demand during stipulated peak and off-peak periods. Provision is generally made so that the demand can be changed on proper notice.

Interchange agreements have been made to require both companies to stand ready to serve each other in case of need up to an agreed-upon maximum demand. When energy is interchanged the rates charged by the two companies are not always on the same basis. For instance, some water-power companies pay more for



C.V.E.Co.— Cedar Valley Electric Co.
C.G.& E.Co.— Continental Gas & Elec. Corp.
C.R.P.Co.— Cuyuna Range Power Co.
D.M.E.Co.— Des Moines Electric Co.
D.E.Co.— Dubuque Electric Co.
G.L.& P.Co.— General Light & Power Co.
G.N.P.Co.— Great Northern Power Co.
I.L.& P.Co.— Interstate Light & Power Co.
I.F.& E.Co.— Iowa Falls & Electric Co.
I.L.H.& P.Co.— Iowa Light Heat & Power Co.
I.R.& L.Co.— Iowa Railway & Light Co.
I.S.U.Co.— Iowa Southern Utilities Co.
M.G.E.Co.— Minneapolis General Elec. Co.
M.U.Co.— Minnesota Utilities Co.
M.R.P.Co.— Mississippi River Power Co.
N.I.G.& E.Co.— Northern Iowa Gas & Elec. Co.
N.S.P.Co.— Northern States Power Co.
O.T.P.Co.— Otter Tail Power Co.
P.G.& E.Co.— Peoples Gas & Electric Co.
P.P.& M.Co.— Peterson Power & Milling Co.
R.R.P.Co.— Red River Power Co.
ST.C.P.S.Co.— St. Cloud Public Service Co.
ST.P.G.L.Co.— St. Paul Gas Light Co.
W.M.L.& P.Co.— Wisconsin Minnesota Light & Power Co.

— LEGEND —
Transmission Lines Operated
Transmission Lines Projected
Transmission Lines under Construction
H.El. Generating Stations Operated
H.El. Generating Stations Projected
St.El. Generating Stations Operated
St.El. Generating Stations Projected
Sub-Station
Interconnection Point

DIVERSIFIED AGRICULTURAL AND INDUSTRIAL REQUIREMENTS SERVED BY WELL-DISTRIBUTED GENERATING STATIONS

energy they buy from steam electric plants than the steam generating companies pay for the hydro-electric energy they purchase in exchange.

All the advantageous interconnections have not yet been made, and while many proposed lines are shown on the accompanying maps, they do not by any means include all of the possible connections which are in the minds of central-station men in the Middle West territory. Nearly every central-station executive is giving the matter of interconnection serious thought from one angle or another, and it seems that there is no company large enough or small enough to ignore its possibilities entirely. The development of high-voltage trunk systems, while not carried to the extent of other sections of the country, is gradually unifying the power resources.

WATER POWER IN FINLAND. — *A recent estimate of water power in Finland which within a reasonably near future will be available at the shaft of the turbine places it at 900,000 hp. There is at least 2,000,000 hp. more undeveloped but too remote to be brought into use for a long period to come.*

DETAILS OF THE INTRICATE NETWORK THAT SERVES THE POWER REQUIREMENTS OF THE MIDDLE WEST

Company	Total Miles of Line in System	Principal Power Stations Location	Rating	Energy Distributed or Wholesale
ILLINOIS				
Commonwealth Edison Co.		Chicago	600,000	D. & W.
Pub. Serv. Co. of No. Ill.....	600	Waukegan	9,800	D. & W.
		Joliet	20,000	
		Oak Park	2,000	
		Blue Is.	48,500	
Ill. Northern Utility Co.....	500	Freeport	1,000	D. & W.
		Dixon	4,000	
		Sterling	1,500	
Cent. Ill.....				D. & W.
Pub. Serv. Co.....	1,000	Kincaid	6,000	D. & W.
		Mattoon	2,000	
Ill. Traction System.....	600	Venice	10,000	D. & W.
		Riverton	10,000	
		Peoria	6,000	
		Danville	8,100	
Cent. Ill. Light Co.....		Peoria	30,000	W. & D.
So. Ill. Lt. & Pr. Co.....		Collinsville	2,500	D
		Hillsboro	3,750	
Mississippi River Power Co.		Keokuk	128,000	W. & D.
INDIANA				
Interstate Public Service Co.		Bedford	9,000	W. & D.
		Williams	8,000	
Ind. & Mich. Elec. Co.....	156	So. Bend	14,000	W
		Elkhart	2,000	
		Berrion Springs	7,200	
		Twin Branch	4,000	
		Buchanan	2,800	
Ft. Wayne & Northern Indiana Trac. Co.....	150	Lafayette	2,000	W. & D.
		Fort Wayne	20,000	
Ind. Gen. Service Co.....	100	Muncie	20,000	D.
		Marion	6,500	
		Elwood	1,000	
Terre Haute, Indianapolis & Eastern.....	325	Terre Haute	11,500	W. & D.
		Indianapolis	76,000	W. & D.
		Lebanon	2,400	W. & D.
		Crawfordsville	1,400	W. & D.
Wabash Valley Elec. Co.....		Clinton	1,100	
Indiana Power Co.....	24	Edwardsport	8,000	W. & D.
Indiana Railway & Light Co.	18	Kokomo	10,400	D
IOWA				
Iowa Railway & Light Co...	1585	Boon	3,000	D. & W.
		Cedar Rapids	30,500	
		Iowa Falls	1,125	
		Marshalltown	2,800	
		Hydro Plants	2,400	
Cont. Gas & Elec. Co.....		Red Oak	1,800	D
		Omaha	33,000	
		Shenandoah	1,650	
Iowa Southern Utilities Co..	240	Centerville	3,500	D. & W.
Des Moines Electric Co.....		Des Moines	30,000	D. & W.
		Oskaloosa	1,200	
Mississippi River Power Co..		Keokuk	128,000	
Iowa Light Ht., Pr. & Co....		Rockwell City	10,000	W. & D.
Citizens' Gas & Elec. Co....		Waterloo	12,500	W. & D.
No. Iowa Gas & Elec. Co.....		Eagle Grove	1,900	W. & D.
		Humboldt	1,100	

Company	Total Miles of Line in System	Principal Power Station Location	Rating	Energy Distributed or Wholesale
OHIO				
Dayton Power & Light Co.	125	Dayton	65,000	D
Ohio Power Co.....		Fremont	19,000	W. & D.
		Newark	11,000	
		Windsor	120,000	
		Canton	28,000	
Penn. & Ohio Electric Co...		Youngstown	72,000	D
Union Gas & Electric Co...		Cincinnati	110,000	W. & D.
		Newport	6,000	
Defiance Gas & Elec. Co...		Defiance	6,500	W. & D.
		Maumee	3,000	
Massillon Electric Co.....		Massillon	8,200	D
MICHIGAN				
Consumers' Power Co.....	1300	Battle Creek	17,500	W. & D.
		Jackson	9,000	
		Flint	13,500	
		Bay City	1,500	
		Mio	5,000	
		Five Channels	6,000	
		Cooke	9,000	
		Foote	9,000	
		Kalamazoo	3,000	
		Grand Rapids	26,000	
		Croton	12,000	
		Junction	17,000	
		Webber	2,500	
Detroit Edison Co.....	550	Detroit	28,000	
		Port Huron	4,000	W. & D.
MINNESOTA				
Northern States Power Co..		St. Croix Falls	18,000	D. & W.
		Cannon Falls	2,200	
		Rapidan	1,500	
		Minneapolis	72,000	
		St. Paul	8,000	
		Coon Rapids	8,000	
Ottertail Power Co.....		Fergus Falls	5,000	D
		Fergus Falls	.....	D
Cuyuna Range Power Co...		Sylvan	1,800	
		Pillager	1,800	D 5,000
		Riverton	1,000	
Little Falls Water Power Co.		Little Falls	4,400	W. & D.
St. Cloud Pub. Serv. Co....		St. Cloud	5,500	D
Great Northern Co.....		Virginia	6,000	D. & W.
		Thompson	54,000	
		Duluth	3,000	
WISCONSIN				
Wis. Valley Elec. Co.....	100	Merrill	1,000	W. & D.
		Wausau	4,000	
W. P. S. Co.....	200	High Falls	6,000	
		Green Bay	4,000	W. & D.
		Manitowoc	7,500	
Wisconsin Edison Company.	350	Milwaukee	80,000	W. & D.
		Racine	25,000	D. & W.
So. Wis. Power Co.....	62	Kilbourn	6,000	W
Wis. River Power Co.....	25	Prairie du Sac 25v	6.000	W
	27	Prairie du Sac 60v	10,000	
Wis. Ry. Lt. & Pr. Co.....		Winona	11,000	
	71	Hatfield	5,000	W. & D.
Wis.-Min. Lt. & Pr. Co....		Wissota	45,000	W. & D.
		Chippewa Falls	27,000	
		Menominee	1,200	
		Cedar Falls	8,000	
		La Crosse	4,500	

Reorganization Program for N. E. L. A.

Work of New Departments at National Headquarters and New Plans for More Effective Functioning of Geographic Divisions, National Sections and Executive Committee

By M. H. AYLESWORTH
Executive Manager National Electric Light Association

CHANGING conditions in the use and regulation of electricity have brought about an immediate need for greater expansion of the National Electric Light Association, coupled with a definite national program which shall assure the continued success of the association as the national representative of the electrical industry. For thirty-five years the National Electric Light Association not only has fulfilled its original object but has courageously assumed the ever-increasing duties and responsibilities which naturally have accompanied the growth in size, influence and importance of the electrical industry.

Following a general survey made by the writer at the request of the national executive committee, upon the recommendation of President Ballard, it was determined to undertake a program of expansion. In answer to a general letter written to executives of all member companies came a demand for increased service in practical co-operation, which resulted in immediate reorganization of the national headquarters staff. The new plan called for the creation of the position of executive manager to direct the work of the association, including the appointment and direction of the headquarters staff, under the supervision of the president, vice-presidents and national executive committee.

M. H. AYLESWORTH

The organization at the headquarters in New York City has been divided into five departments, under the direction of an executive manager. The functions of all of these departments and of the department of education, with its headquarters at Chicago, are outlined in the paragraphs that follow:

Company Service Department.—The rate book and rate research work, which heretofore has been carried on in Chicago, has become a part of the centralized organization, with Fred W. Herbert, superintendent of the company service department, in charge. This department is co-operating also with accounting committees and is prepared to give service to companies, large or small, in the matter of technical accounting, rates, valuation, production, service or other problems. In so doing this department will act as a clearing house for information, experience, statistics and all such matters, thus giving to small and large companies alike the advantages of practical development demonstrations of the other company members. Already numerous inquiries requesting advice on operating matters of all kinds have been received.

Department of Publicity.—This department functions under the direction of George F. Oxley as director, who will supervise the gathering of educational propaganda material from all parts of the country for dissemination to all member companies and to the public. As part of the campaign to inform the public on all matters affecting the electric utilities member companies throughout the country will be aided in carrying on this work and in turn will be called on for assistance. This department will assist in the organization of state committees on public utility information and will act as a clearing house for the committees already formed and those which will be organized during the coming year. The fact is recognized that all publicity problems which are purely local in character or extent must be handled exclusively by local member companies or by state associations or geographic divisions; however, many of the problems and conditions which confront the electric light and power companies are common to all and should therefore be handled through the publicity department at headquarters. The work of this department includes the utilization of the moving-picture industry and educational work through the medium of educational institutions. The department of publicity will supervise the publication of the monthly bulletin of the association and will distribute to the membership letters of information regarding its activities and developments within or affecting the industry.

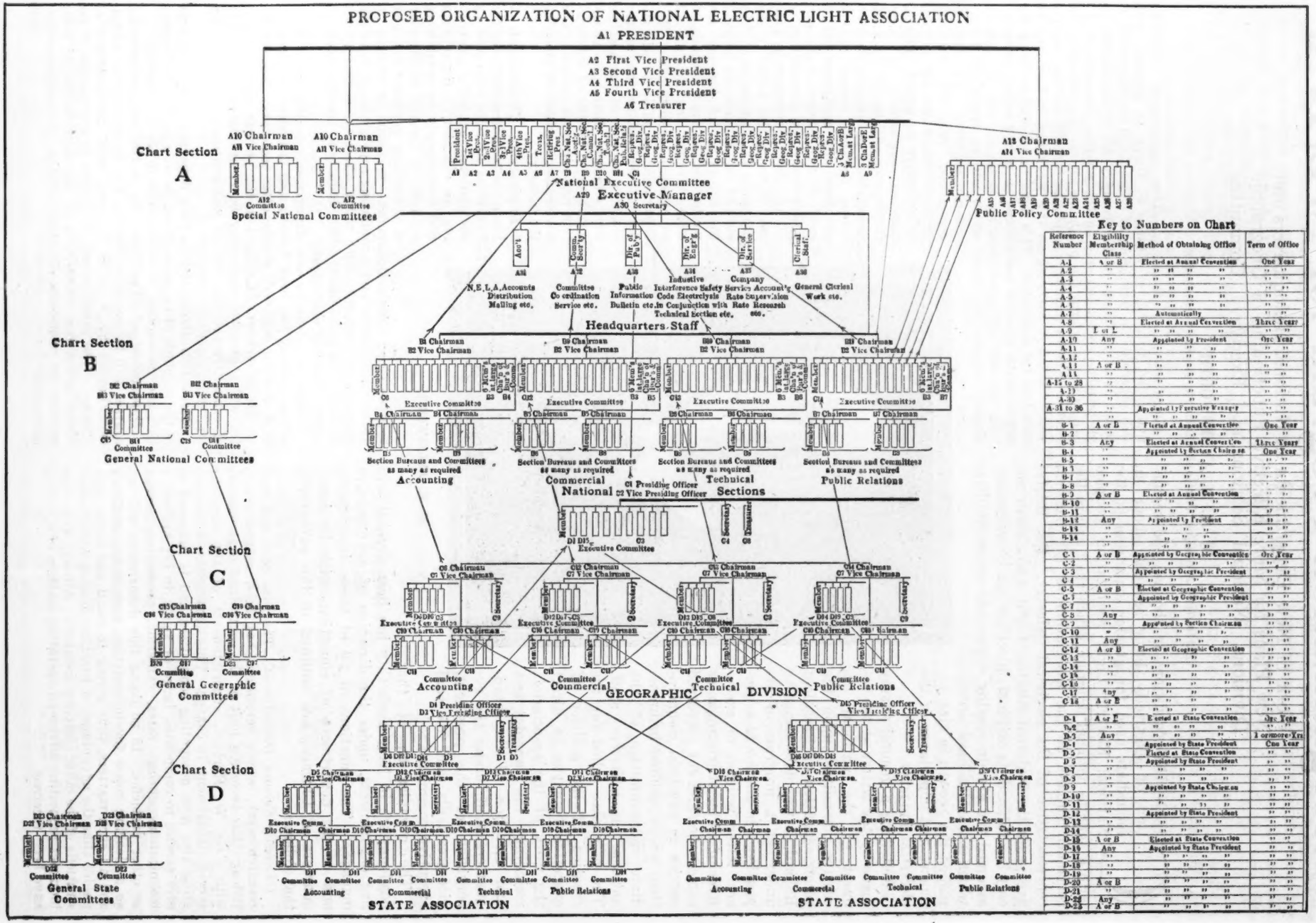
Engineering Department.—Upon the recommendation of the Technical Section, approved by the national executive committee, an engineering department will immediately be established with W. J. Canada as director. A consulting engineer has also been retained. This department is about to engage in gathering statistics and formulating a program on practical engineering problems which today affect the industry, and it will deal particularly with inductive interference, the safety code and electrolysis.

Committee Activity.—A department dealing with committee activity has been formed and is under the direction of A. Jackson Marshall as committee secretary. The service of this department is offered to the various committees to the end that their work may be co-ordinated, duplication of committee activity avoided and continuity of committee and section activity assured.

Accounting Department.—This department is in charge of the accounts of the association, as well as the membership lists and the mailing of all material to the membership.

Department of Education.—As in the past, educational courses will be available through the department of education, headed by Fred R. Jenkins, with headquarters at Chicago. The rapid growth of classes in every state of the Union is the best illustration of the appreciation of these courses by members of organizations of central-station companies.

PROPOSED ORGANIZATION OF NATIONAL ELECTRIC LIGHT ASSOCIATION

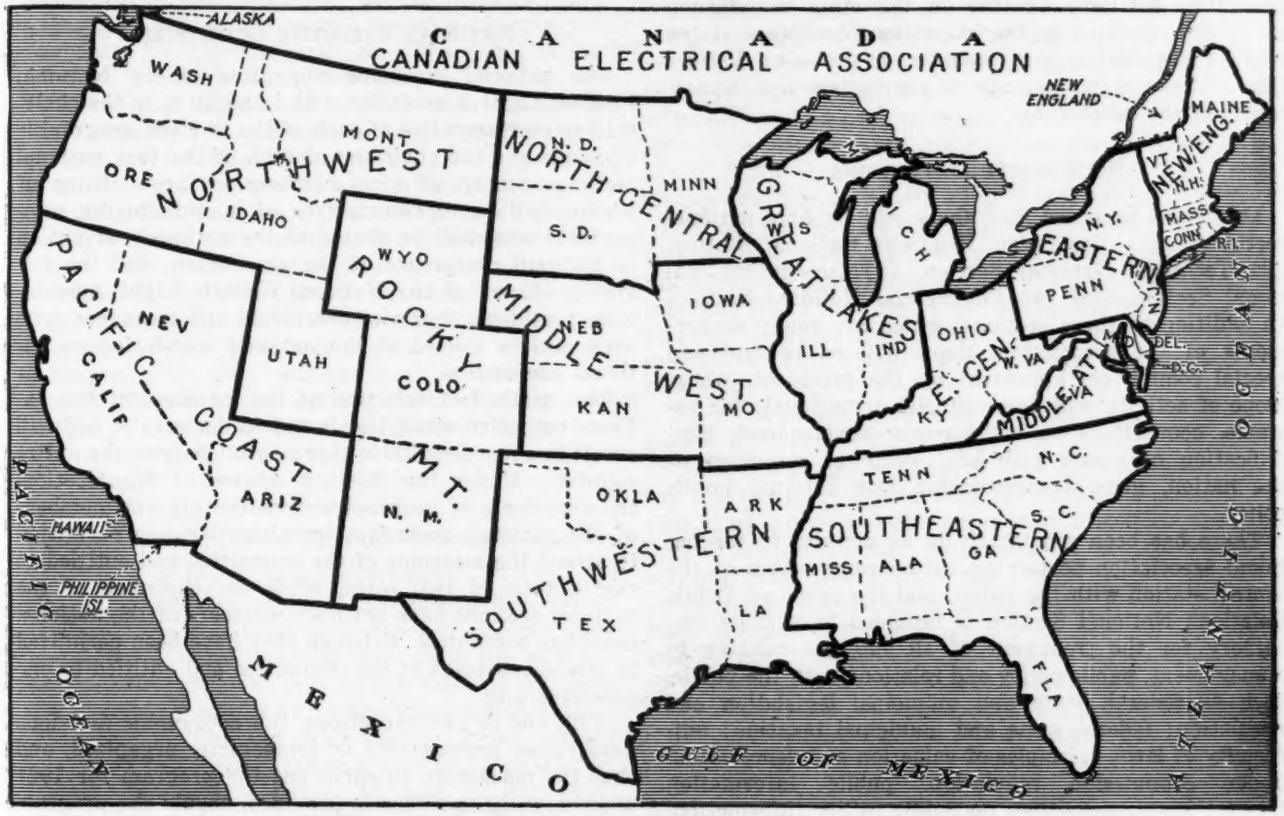


Key to Numbers on Chart

Reference Number	Eligibility Membership Class	Method of Obtaining Office	Term of Office
A-1	A or B	Elected at Annual Convention	One Year
A-2	"	" " " "	" "
A-3	"	" " " "	" "
A-4	"	" " " "	" "
A-5	"	" " " "	" "
A-6	"	" " " "	" "
A-7	"	Automatically	" "
A-8	"	Elected at Annual Convention	Three Years
A-9	I or L	" " "	" "
A-10	Any	Appointed by President	One Year
A-11	"	" "	" "
A-12	"	" "	" "
A-13	A or B	" "	" "
A-14	"	" "	" "
A-15 to 28	"	" "	" "
A-29	"	" "	" "
A-30	"	" "	" "
A-31 to 36	"	Appointed by Executive Manager	" "
B-1	A or B	Elected at Annual Convention	One Year
B-2	"	" "	" "
B-3	Any	Elected at Annual Convention	Three Years
B-4	"	Appointed by Section Chairman	One Year
B-5	"	" "	" "
B-6	"	" "	" "
B-7	"	" "	" "
B-8	"	" "	" "
B-9	A or B	Elected at Annual Convention	" "
B-10	"	" "	" "
B-11	"	" "	" "
B-12	Any	Appointed by President	" "
B-13	"	" "	" "
B-14	"	" "	" "
C-1	A or B	Appointed by Geographic Convention	One Year
C-2	"	" "	" "
C-3	"	Appointed by Geographic President	" "
C-4	"	" "	" "
C-5	A or B	Elected at Geographic Convention	" "
C-7	"	Appointed by Geographic President	" "
C-8	"	" "	" "
C-9	"	Appointed by Section Chairman	" "
C-10	"	" "	" "
C-11	Any	" "	" "
C-12	A or B	Elected at Geographic Convention	" "
C-13	"	" "	" "
C-14	"	" "	" "
C-15	"	" "	" "
C-16	"	" "	" "
C-17	Any	" "	" "
C-18	A or B	" "	" "
"	"	" "	" "
D-1	A or B	Elected at State Convention	One Year
D-2	"	" "	" "
D-3	Any	" "	1 or more Yrs
D-4	"	Appointed by State President	One Year
D-5	"	Elected at State Convention	" "
D-6	"	Appointed by State President	" "
D-7	"	" "	" "
D-8	"	" "	" "
D-9	"	Appointed by State Chairman	" "
D-10	"	" "	" "
D-11	"	" "	" "
D-12	"	Appointed by State President	" "
D-13	"	" "	" "
D-14	"	" "	" "
D-15	A or B	Elected at State Convention	" "
D-16	Any	Appointed by State President	" "
D-17	"	" "	" "
D-18	"	" "	" "
D-19	"	" "	" "
D-20	A or B	" "	" "
D-21	"	" "	" "
D-22	Any	" "	" "
D-23	A or B	" "	" "

A department operating in conjunction with the committee on company sections and employees' clubs is contemplated. The province of this department will be to assist in the organization of company sections and employees' organizations through correspondence, suggestions and field work where necessary.

While the organization at headquarters was being perfected the officials of the national association were obtaining the views of the representatives of member companies in attendance at state association conventions and geographic division conferences, and by written questionnaires. As a result of this investigation a special committee on reorganization was appointed. Its completed plan, visualized by the accompanying chart and supported by the proposed constitutional amendments necessary to bring about the machinery for the organization, will be submitted to the membership and will be voted upon at the convention at Pasadena, May 18 to 22.



PLAN FOR GEOGRAPHIC DIVISIONS APPROVED BY N. E. L. A. HEADQUARTERS

On Oct. 1, 1919, there were five geographic sections of the National Electric Light Association, composed of two or more states, and seven state geographic sections. Twenty state electrical or public utilities associations existed which were not affiliated with the National Electric Light Association, although the electric central-station members of these twenty state associations were, with few exceptions, Class A members of the national association. The field work carried on since Oct. 1 not only has demonstrated that the work of the national association should be decentralized to a considerable extent and that the country should be organized by geographic divisions, but that there is a unanimous demand for the program of the geographic sections committee, which provided for the division of the country into thirteen geographic sections, including Canada, as defined and named on the accompanying map. The national executive committee may, on its own motion or upon the application of one or more adjacent geographic divisions, modify the boundaries or add to or subtract from the existing number of geographic divisions.

GEOGRAPHIC DIVISION ORGANIZATION

The proposed plan provides two methods of geographic division organization. With certain geographic divisions there exist strong and active state electrical associations or state public utilities associations, while in others, where no state association machinery exists, the geographic division carries on the activities of the membership within the division. Thus it will be seen that the Northwest Electric Light and Power Association, for example, may continue to hold its annual convention and its executive conference or committee meetings without regard to state boundaries, while the proposed Great Lakes division, for example, composed of the States of Wisconsin, Michigan, Indiana and Illinois (two of which states had been affiliated with the national association as state geographic sections, while the other two were unaffiliated), will function through a geographic conference, composed of delegates from the four state associations, who will select the officers of the Great Lakes division and carry on the activities of the national association within the boundaries of the division, the state associations continuing to function in all local matters and, in addition, carrying on their activities as integral parts of the geographic division of the national association.

The purpose of geographic division organization is to decentralize where possible the activities of the national

association and harmonize the work of the state association, geographic division and national association through co-ordination of all committee activities from the state association, through the geographic division, and finally into the executive committee of the national association. Where state public utilities associations exist, it is proposed that the electric light and power branch or division of the state association affiliate as part of the geographic division.

Assistance in financing the geographic division will be provided upon budgetary appropriation from the dues paid to the National Electric Light Association. The needs of each geographic division, in budget form, will be presented for approval to the national executive committee by the representative of each geographic division upon the national executive committee. As the proposed plan provides for the elimination of all duplication of committee activity, whether in the state association, geographic division or the executive committees of the national association, it is important to provide a distinct line of division in the scope of committees and departments of the association.

FOUR NATIONAL SECTIONS

Under the proposed plan there will be four national sections: (1) The Public Relations National Section, (2) Technical National Section, (3) Accounting National Section, and (4) Commercial National Section. In addition to these sections, which are really departments of the association, there will be general and special committees appointed by the president, whose scope of activity will be territorial or national; for example, committees on water-power development, electrification of steam railroads, electrical resources of the nation, general membership and national public policy.

There has been comparatively no activity in the national association pertaining to the relationship of the central station with the public, and the proposed Public Relations National Section is intended to provide machinery for the treatment of all subjects relating to management, public policy and relations with the public, such as federal, state and municipal legislation and regulation; federal, state and municipal taxation; uniformity of laws, principles of valuation and depreciation under commission regulation, public information through state committees on public utility information, public utility financing, including customer ownership of securities; municipal ownership, co-operation within the industry and all subjects of similar nature which heretofore have been handled by other national sections and committees of the association.

It has been further provided that the officers of the Public Relations National Section shall be a chairman, vice-chairman and executive committee, consisting of five members at large, to be elected at the national convention or national conference of the association, and the chairman of the public relations section of each of the thirteen geographic divisions of the national association.

Activities of the public relations section within the geographic division shall be controlled by an executive committee consisting of the chairman of each of the state associations' committee on public relations. The membership of the Public Relations National Section will consist of the executive officers of Class A member companies.

The proposed Technical, Accounting and Commercial National Sections are substantially the same in character and structure as those which exist at present, except in so far as their organization is affected by automatic representation from state and geographic divisions, as now proposed.

The chairman of each of the four national sections will become a member of the national executive committee of the association and will present to the national executive committee the section program for the administrative year for approval.

The Public Relations National Section will be represented on the national public policy committee by four members of the executive committee of the section, who shall be recommended by the chairman of the section and indorsed by the chairman of the national public policy committee.

NATIONAL EXECUTIVE COMMITTEE

The national executive committee of the National Electric Light Association will, in addition to the chairman or representative of each of the thirteen geographic divisions and the chairman of each of the four national sections, consist of nine members at large (three of whom shall be representatives of manufacturing companies), who shall be elected at the national convention or national conference of the association, and the following officers of the National Electric Light Association, president, four vice-presidents and treasurer, who shall also be elected at the national convention or national conference.

This method of selection of the members of the national executive committee is indeed democratic and will result in a more equitable representation from the entire country. Under the existing scheme of organization, the presidents of geographic divisions are not members of the national executive committee but are permitted to attend the meetings of the committee and entitled to cast a total of two votes, while the chairmen of the national sections have not been members of the national executive committee, although they have been permitted to attend meetings of the committee and entitled to one collective vote.

With one or two exceptions, the geographic divisions have either permanently or temporarily organized, and thus the machinery to carry out the program for 1921 and the years to follow is provided, should the program receive the official approval of the membership in convention assembled.

COMPLETE CO-OPERATION BETWEEN ALL BRANCHES

The plan of organization provides for complete co-operation between all branches of the industry by inviting the manufacturer, contractor-dealer and jobber to take a definite part in the work of the association, but does not contemplate absorption, consolidation or abandonment of the national organization of any of the different branches of the industry. In other words, the entire plan of organization is based upon the co-ordination of the interests and activities of the industry in the several states of the Union, working through state associations where they exist, and thence through geographic divisions into the executive committee of the national association, so that every member company and its individual membership shall have a voice in the program and management of the National Electric Light Association.

Readers' Views and Comments

Standardizing Panelboards

To the Editor of the ELECTRICAL WORLD:

SIR: We believe that the manufacturers of panelboards and cabinets need a great deal of education in the value of standardization. Panelboards and cabinets are still made today according to the individual idea of each factory, and the consequence is that no one—architect, engineer or contractor—has any standard to follow, and therefore any one in control specifies his own particular ideas for an individual job. The result is that panelboard manufacturers, instead of running the switchboard and panelboard manufacturers' business, are each running a jobbing shop and making up material only for every individual job ordered.

To further the storage of all materials it appears to be a good time to agree on standardization along the lines pursued by the conservation committees during the war. We desire particularly to urge upon our competitors in the switchboard, panelboard and steel-cabinet business the value of the manufacturers first getting together on reasonable standards of design and construction and then asking their customers, the architects, the engineers and the contractors, to take advantage of this work. FRED B. ADAM,

Secretary Frank Adam Electric Company.

St. Louis, Mo.

High-Tension Direct-Current Transmission

To the Editor of the ELECTRICAL WORLD:

SIR: The economical limit of alternating-current transmission has apparently been reached at somewhere around 150,000 volts, since at this point the effective pressure of over 200,000 volts at the crest of the wave begins to produce corona and other losses which balance any saving. If, however, high-tension direct current were available, the same line that carries 150,000 effective volts with a peak voltage of over 200,000 would carry an effective direct-current voltage of 200,000 volts with no greater peak voltage. In addition, the direct current would all be useful; there would be neither a lagging nor a leading current to gum up the service. Calculations show that high-tension direct current would triple the capacity of a line for the same losses.

There are, however, two problems to be solved. The first is as to whether the steady pressure of the direct current with its possible electrolytic dangers will cause more trouble than the varying alternating-current pressure. Almost the only data available are the data from the Thury lines at 60,000 volts to 70,000 volts. These apparently indicate no increase of trouble from direct current. That there is no trouble at 60,000 volts attributed to the current being direct current instead of alternating is no proof that trouble would not develop at 100,000 volts or 200,000 volts, but it is certainly no proof that trouble will develop.

The chief trouble about high-tension direct current is the cost of producing it. The Thury system provides series direct current by use of several dynamos in series. While the Thury system often works out well on paper and while it is occasionally successful in practice, yet its use does not spread, and this alone is almost sufficient to show that success must be looked for along other lines. The trouble with the Thury system is apparently inherent in the use of machines of not more than 5,000 volts, and this, therefore, involves the series system in order to obtain the necessary high voltage.

The problem is to get the high voltage from machines of large capacity and to get multiple direct current for transmission even if this should be again converted to multiple alternating current for distribution. So far the production of really high direct-current voltage has been limited to the mercury rectifier, or kenetron, and to machines designed on the principle of revolving the commutator only, as in the Hulin-Le Blanc machines. These, however, have been built commercially only for small sizes of 5 kw. or so.

The problem is: Can they be built in large sizes? Some designers say no, but let us consider two things in the history of the art. The first is the story that when power was first produced by electricity—that is, when the first electric motor was shown—some one asked, "Can that ever be used practically?" and the answer was to stop it with a touch of the finger and say, "This will always be a toy." In the same way the steam turbine (invented two hundred years ago) was only a toy until designer and machinists showed that it was no inherent limit that had kept the steam turbine small and that accurate design and workmanship could build, first 10-kw., then 100-kw., then 1,000-kw. and 10,000-kw. machines.

For some things there is an inherent limit. We never expect to use iron for strength at temperature much above 500 deg., nor any material at temperature above say 1,500 deg. C. We have no expectation of using voltages much above 200,000, because at that point the air breaks down. We have no expectation of ever getting material that will sustain more than 300,000 lb. per square inch. On the other hand, we can handle 120,000 volts alternating current on a peak voltage of about 200,000 volts, and we can take 120,000 volts alternating current and change it to 200,000 volts direct current without reaching any limit except in accuracy of design.

It is true that we do not yet know just how we shall do it, just as De Laval and Parsons and Curtis did not at first know how the big turbines were ever to be built. Our ancestors built muzzle-loading firearms for centuries until they worked out how to seal the breech, but now a 16-in. breech-loading gun is merely a matter of mechanical precision. Does it not, therefore, follow that the converter to produce high-tension direct current is in much the same position today that the turbine and the breech-loading gun were two hundred years ago or one hundred years ago?

We don't know whether direct-current high-tension transmission will come in one hundred years or two hundred years (or perhaps ten years, since when it does come it may come fast), but it is pretty sure to come. Already designs have been put on paper and some have been put into copper and iron, and they have all so far failed. We cannot blame the manufacturer for refusing to take long chances with but small chances of profit, but we can at least predict that high-tension direct-current transmission will some day enable a given amount of copper to carry about three times the kilowatts that it does now. KASSANDRA.

Boston, Mass.

Station and Operating Practice

A Department Devoted to Problems of Installation, Operation and Maintenance of Equipment for Economical Generation and Distribution of Electrical Energy

Oil Firing Costs $1,200 Less Per Month for Boilers Rated at 1,000 Hp.

ABOUT $1,205 per month in labor was saved on four 250-hp. boilers by installing fuel-oil burners in place of the coal furnaces of the Economy Steam Heating & Electric Company, Sedalia, Mo. The former cost of firing coal was 14.4 cents per 1,000 lb. (454 kg.) of steam, while with oil this has been reduced to 2.4 cents, giving a saving of 12 cents per 1,000 lb. Regarding labor this plant formerly used twelve men in three shifts of eight hours with four men each. With oil firing two men can handle the work, each on a twelve-hour shift, and they are perfectly contented with the arrangement. The ease of firing as compared with the former hand firing of coal has made them willing to work the longer shift for the extra money. The fuel expense in the installation has remained about the same, as oil of 19,000 B.t.u. costs $1.50 per barrel at the boiler house, and coal of 9,000 B.t.u. costs $5. With this coal the cost of evaporation was 48 cents per 1,000 lb. Therefore the net saving per 1,000 lb. of steam is the 12 cents attributable to labor, or 25 per cent of total costs. Moreover, other advantages have been obtained from the oil fuel, such as ability to obtain a higher boiler output and to carry a more fluctuating load, lower cost of banking boilers, and ease in keeping the heating surfaces clean.

In making this change during the coal famine in the fall of 1919 it was necessary to remove the grates and boiler bridge walls and to install the checker work and piping. A five-car storage tank, unloading pump, oil pump and heater burners were already in place. The total cost charged to making the change is as follows:

Storage tank, pumps, heater burners, etc....	$550
Piping, fittings, etc.....	250
Labor, including overhead expense.....	300
Total	$1,100

Based on these costs, the cost per boiler-horse-power is $1.10 for the complete installation.

Sedalia, Mo. H. A. WOODWORTH.

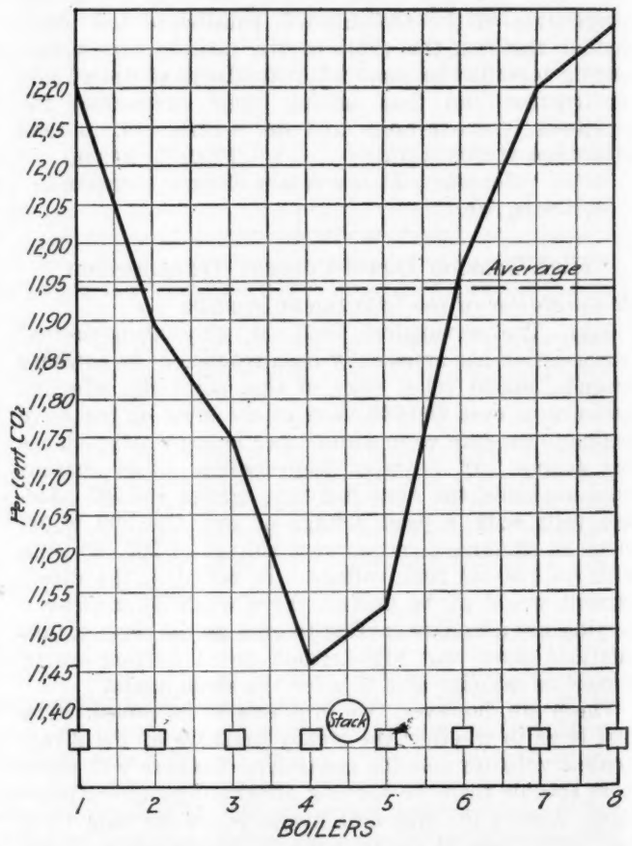
Overload Trouble Traced to Loose Millivolt Connections

DIRECT-CURRENT ammeters in which there is a millivolt circuit taken from an ammeter shunt may read low if the millivolt terminals are not properly tightened. It can be understood that when a manufacturer measures the wire between the ammeter shunt and the ammeter a change of resistance due to a poor connection will affect the reading of the instrument considerably. At one plant where five exciters were connected to an exciter bus a loose connection in the millivolt wiring caused one exciter to be overloaded when running in parallel with the other four. The overloaded exciter commutator was nearly ruined when the trouble was found. The trouble was remedied, however, after the commutator was turned down and the loose connections were properly tightened. L. W. WYSS.

Iron Mountain, Mich.

Distance of Boiler from Stack Influenced Amount of CO_2 in Flue Gas

CAREFUL analysis made of the flue gas from boilers of the Long Beach steam plant of the Southern California Edison Company under the direction of the superintendent of generation, R. J. C. Wood, has disclosed the fact that there is a definite relation between the location of the boilers with reference to the stack and the average CO_2. The curve shows this very clearly. Those boilers that are nearest the stack have a percentage of CO_2 considerably lower than those further away. This curve is based on the average daily analysis as made by the recording CO_2 machines which are installed on each boiler. Charts covering a period of 125 days were averaged to obtain the data plotted.



BOILERS NEAREST TO STACK HAVE LOW CO_2

Chart Used with Two Wattmeters to Determine Power Factor

FOR quickly determining the power factor of a balanced three-phase circuit the accompanying chart may be used in conjunction with two single-phase wattmeters connected to read the total power of the circuit they must be connected as *A* or *B* in the chart. To use the chart values corresponding to the readings from the respective meters are marked on the two side scales of the chart and a straight-edge is laid across the chart

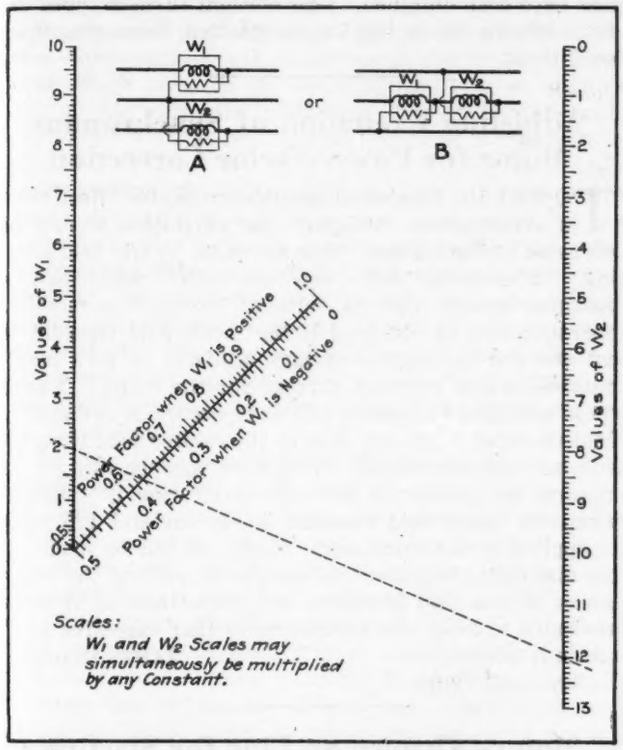


CHART FOR FINDING POWER FACTOR FROM TWO SINGLE-PHASE WATTMETER READINGS

through these values. Then the point where this straight-edge crosses the diagonal line gives the power factor the circuit. In case the readings of the wattmeters do not fall within the limits of the side scales, the readings may both be divided by any suitable number so that they will fit. As an example, say the meter W_1 reads 20 kw. while W_2 reads 120 kw. As neither of these values falls within the scales, each is divided by 10, giving 2 and 12, which fall on the scales and which give a power factor of about 0.63. It must be noted that when one of the meters reads negative the power factor is below 0.50 and in using the chart the figures underneath the diagonal line must be used. If, in the foregoing example, readings of W_1 had been negative, the power factor would be 0.38.

This chart was drawn with values obtained by use of the formula

$$PF = \frac{W_2 + W_1}{\sqrt{(W_2 + W_1)^2 + 3(W_2 - W_1)^2}},$$

which holds in case of two single-phase wattmeters connected as shown by the chart on a three-phase balanced circuit.

For determining the average power factor over a certain length of time two watt-hour meters may be used. Several central-station companies are determining the average power factor of customers by this method.

RUSSELL G. WARNER.

New Haven, Conn.

Installation Costs of Diesel Engines

COSTS of four-cycle, four-cylinder engines direct connected to three-phase, 60-cycle generators of 80 kw. to 350 kw. rating, as shown in the accompanying table, amount to $125 to $105 per horsepower f.o.b. factory. For the purpose of comparison with the cost of other engines the cost per pound may be used in addition to the cost per horsepower. The same engines which have already been referred to cost from 33 cents to 29 cents per pound f.o.b. factory (15 to 13 cents per kg.). The figures given in the table were prepared by an engine manufacturer in November, 1919, for the use of his men in the field. In addition to the cost of the engines the cost of the proper-size alternating-current, 60-cycle generator is given, as are all items of installation expense except land, buildings and fuel-shortage tanks. A 15,000-gal. (58,000-l) steel storage tank could be purchased for $730 f.o.b. the tank factory at the time these figures were compiled. Such tanks have been installed above ground on concrete saddles at a cost of between $1,000 and $1,200 complete.

S. N. CLARK.

Chicago, Ill.

INSTALLATION COSTS OF DIESEL ENGINE-GENERATOR UNIT

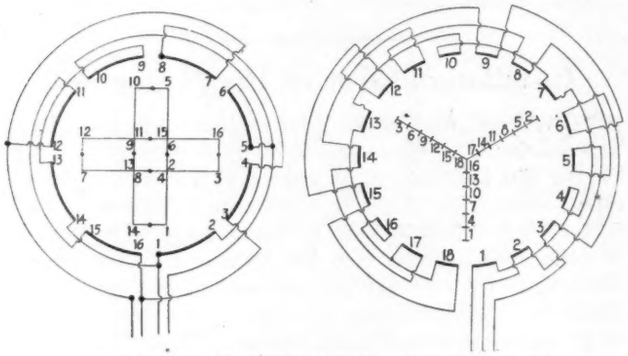
B.-hp. engine	120	165	180	250	365	420
Kw.-generator	80	110	120	170	250	350
R.p.m.	300	276	300	257	225	200
Shipping weight with heavy wheel, lb.	47,100	61,600	61,600	92,000	135,400	200,000
Foundations, cu.yd.	40	50	50	70	90	120
Tentative price engine and standard equipment, f.o.b. factory	$15,000	$19,800	$20,400	$28,750	$40,150	$54,600
Freight at 50c. per 100 lb.	236	308	308	460	677	1,000
Hauling at $5 per ton	118	154	154	230	339	500
Erection—Travel	75	75	75	75	75	75
Time and expense	475	510	510	600	715	950
Labor	250	300	300	350	400	450
Piping-engine room (estimated)	340	340	340	450	615	830
Total, engine delivered and erected	$16,494	$21,487	$22,087	$30,915	$42,971	$58,405
Generator, 2,300-volt, three-phase, 60-cycle, and belt exciter, f.o.b. works	$1,880	$2,125	$2,300	$2,525	$3,085	$4,740
10 per cent for foundation bolts, pulley, belt, contingencies	190	215	230	250	310	475
Approximate shipping weight, including exciter, lb.	(5,500)	(7,000)	(8,000)	(9,500)	(12,000)	(14,500)
Freight, at $1 per 100 lb.	55	70	80	95	120	145
Hauling and erection (estimated)	100	100	100	150	175	200
Generator and exciter delivered and erected	$2,225	$2,510	$2,710	$3,030	$3,690	$5,560
Complete engine generator unit	$18,719	$23,997	$24,779	$33,945	$46,661	$63,965
Foundations, at $12 per yd.	480	600	600	840	1,080	1,440
Total complete unit delivered and erected, including foundations	$19,199	$24,597	$25,379	$34,785	$47,741	$65,405

Industrial Applications

The Economical Utilization of Electrical Energy
in Mills and Factories, Together with Practical Details of Installation, Control, Testing and Repair of Equipment Required

Two-Phase Motor Reconnected for Three-Phase Operation

CHANGING a two-phase, 220-volt, 40-cycle motor to operate on a three-phase, 550-volt, 60-cycle circuit without rewinding was a task accomplished during the war by a Connecticut shop. This motor was wound with seventy-two coils in seventy-two slots connected two in parallel for four poles, giving a speed of 1,200 r.p.m. As the speed was to be the same after the change it was found by applying the formula (2 × 60 × 60 cycle) ÷ number of poles = r.p.m., that the poles



TWO-PHASE, 40-CYCLE MOTOR RECONNECTED FOR THREE-PHASE, 60 CYCLES

should be increased to six. There were originally 72 ÷ 4 or 18 slots per pole, and 180 ÷ 18 = 10 electrical degrees per slot. As the throw of the coils was one to fifteen or fourteen slots, there were 14 × 10 = 140 electrical degrees per coil, giving a chord factor of sin 140 ÷ 2 = 0.94.

The throw for full pitch with six poles is 72 ÷ 6 = 12 slots per pole or 180 ÷ 12 = 15 deg. per slot. Therefore if the coils were not rewound the chord factor with six poles would be sin (14 × 15) ÷ 2 = sin 210 ÷ 2 = 0.98. When the windings were connected series-star the voltage was (taking into consideration this change from two-parallel to series, two-phase to three-phase, 40 cycles to 60 cycles, four poles to six poles, and 0.94 to 0.98 chord factor) 220 × 2 × (2 ÷ 3) × (60 ÷ 40) × (4 ÷ 6) × (0.98 ÷ 0.94) × 1.73, or 527 volts. As this was only 6 per cent below 550 volts, the motor was connected in this way and operation afterward showed that it did not overheat. CHARLES A. AUBREY.

Bridgeport, Conn.

Electrical Energy Consumed in Making Yellow Brass

THE consumption of electric energy under average conditions of eight-hour to ten-hour operation is as low as 240 kw.-hr. per short ton of yellow brass and 275 kw.-hr. per ton for red brass in the induction or arc furnaces, according to H. M. St. John. In twenty-four-hour operation figures as low as 200 kw.-hr. per ton or less have been obtained. Less efficient furnace types use from 400 kw.-hr. to 500 kw.-hr. per ton, depending upon conditions.

Adjusting Excitation of Synchronous Motor for Power-Factor Correction

TO GET the maximum possible corrective effect from a synchronous condenser the excitation should be adjusted to the highest value allowable by the field heating. If the motor has a separate exciter which can be operated at any desired voltage, the most economical operation can be obtained if the motor-field rheostat is cut out and the exciter voltage adjusted to give maximum allowable exciting current for the motor. Under these conditions no waste of power occurs in the motor-field rheostat, while any loss in the exciter field rheostat will be relatively small. With most modern designs of motors, the maximum allowable excitation is obtained when the motor-field rheostat is cut out and 125 volts is applied to the windings. Marks should be made on the dial plates to guide the operator in setting the regulators at the best position, and sometimes it is even advisable to block the regulators so that excessive excitation is impossible. JAMES DIXON.

Cleveland, Ohio.

Motors Thrown on Line for Starting in Regrinding Mills

THROWING the motors directly on the line without auxiliary control devices such as compensators, etc., has become standard practice in starting the regrinding mills of the Michigan copper mines. These mills, called "conical" mills in that locality, are used in the secondary process of copper extraction, regrinding the sand from the steam stamp mills after it comes from the first washing. The grinding is done by loose steel balls in the cone-shaped tank, and the motor required to drive such a mill varies from 50 hp. for a 6-ft. (1.8-m.) mill to 75 hp. for an 8-ft. (2.4-m.) mill. Voltages are either 440 or 2,200, depending on the practice of the company. In either case, however, the only control equipment is an oil switch with overload trip coils and a low-voltage release. In starting a motor the trip coils are made inoperative by holding the cores, a suitable holding lug being provided for that purpose. This allows the cores to be set for close protection under running conditions and yet permits starting on the line. In case an ammeter is used it is short-circuited with a plug switch at the time of starting.

Men with the copper-mining companies report that excellent results have been attained with this method, which has been in use for six or more years. The starting switches have in no case given so much trouble as was experienced with control equipment.

Methods of Operating Valves by Motor

VALVES suitable for operation by electric motor may be classed as: (1) Valves with conical or similar seatings upon which the valve may be jammed: (2) Sluice valves, penstocks and similar types, where the valve consists of a plate held in guides and operated up and down by means of a worm or screw gear. Considering valves with seatings, it is possible for a valve to become so jammed on its seat that a directly connected motor may become seriously overloaded before it moves. To overcome this difficulty it is preferable to drive through a clutch and use a high-speed motor, enabling the momentum of the motor armature to be utilized. The clutch may be of the slipping type, so that on closing the valve the maximum effort is applied until the clutch slips to insure that the valve is tight on its seat.

In opening the valve after the motor is up to full speed the clutch is applied in such a way that the momentum breaks the static friction and enables the motor to open the valve. A simple claw clutch may be used with an overload relay trip, or two separate overload relays may be used for opening and closing the valve respectively. The motor should be compound-wound so as to speed up, say 20 per cent, between full load and one-sixth full load and thus to obtain full flywheel effect of the armature.

In case the valve plate is lifted vertically the plate should be balanced, as the load at opening is in excess of that during closing when the weight of the valve plate is assisting the motor. A series-wound motor should be used, and for large unbalanced valves potentiometer control should be employed for the closing side. Limit switches should be provided for both the closed and open positions, and in many cases indicating lamps are required to indicate the position of the valve. In general the motors and control gear have to work in damp locations, steam or water usually being present. Therefore the motor should have gum-impregnated windings and should be at least drip-proof. This also applies to the control gear, which should be drip-proof with parts well protected against moisture.

Liverpool, England. MARK MEREDITH.

Losses Resulting from Use of Improper Brushes

FLUSH mica commutators require a brush with sufficient abrasive action to remove the mica as rapidly as the copper is worn down. On the other hand, undercut commutators require brushes with a minimum of abrasive effect in order to keep the wear on the commutator and the power lost in friction as low as possible. The use of abrasive brushes on unslotted commutators will quickly wear them down and fill up the slots with copper dust, resulting in short circuits and burned-out armatures. It is obviously impossible to secure a brush which will not gradually wear away the commutator, but with an abrasive brush operated at 2 lb. per square inch (140 gr. per sq.cm.) the loss on the average machine is about 2½ per cent of its rating. The brush friction losses on a 100-kw. generator operating at full load ten hours per day 300 days per year would therefore cost about $112.50 per annum if energy cost 1.5 cents per kilowatt-hour. The major portion of this expense can usually be saved on slotted commutators when the proper kind of brush is used and the proper tension is maintained.

A brush pressure of about 1.75 lb. to 2.25 lb. per square inch (125 gr. to 160 gr. per sq.cm.) is generally used on slotted commutators under average conditions. For elevator and mill type motors, however, 2 lb. to 3 lb. (140 gr. to 210 gr.) brush pressure is recommended, on crane motors 3 lb. to 5 lb. (2.0 gr. to 350 gr.) and for railway motors 4 lb. to 7 lb. per square inch (280 gr. to 490 gr. per sq.cm.).

Lubricants are not generally satisfactory for use on undercut commutators. The addition of a lubricant tends to hold carbon dust and dirt in the slots and causes short circuits and burned-out coils. Ordinarily the proper type of brush contains enough lubricant. This is especially true when graphite brushes are used.

Cleveland, Ohio. DONALD S. MERTON.

Number of Wires in Conduit Limited by Heating

WHERE a very large number of the smaller-size wires are contained in a large conduit and where these wires are allowed to carry their full rated current for any great length of time the inner wires of the group reach a temperature which would soon destroy the installation and possibly ignite it. This is the opinion expressed in the 1920 report of the rubber-covered wire committee (V. H. Tousley, Chicago, chairman) of the Western Association of Electrical Inspectors. For this reason the committee recommended that not more than nine conductors be used in a single conduit when each wire carries its full rated current.

In special cases requiring more than nine wires in a conduit the committee recommended that the current carried by the wires be limited so that the aggregate I^2R loss would not exceed that of the largest wire permitted in the particular size conduit under consideration when carrying its rated current. These considerations will limit the application of the formula in the article "Correct Conduit Sizes," on page 533 of the ELECTRICAL WORLD for March 13, 1919. An illustration of the way in which the rule is to be applied is given in the following example:

According to the formula given in the 1919 report of the committee, forty-three No. 14 (2.08 sq.mm.) wires could be placed in a 2-in. (50-mm.) conduit. In the same size conduit the code allows a 1,000,000-circ.mil (506.7-sq.mm.) conductor. This has current-carrying capacity of 650 amp. and its resistance is 0.0000108 ohm per foot (0.0000354 ohm per meter). The permissible I^2R loss on the conduit is therefore 4.563 watts per foot (14.95 watts per meter). The forty-three wires which are to be placed in the 2-in. (50-mm.) conduit would hence be allowed to carry only that current which would give an equal I^2R loss in the aggregate. The 4.563 watts divided by the number of wires (forty-three) gives a loss of 0.318 watt per wire. The square root of this wattage divided by the resistance of the No. 14 wire gives 6.4, which is the current that each No. 14 wire would be allowed to carry when there are forty-three wires in the conduit.

These rules apply only to complete conduit systems and are not applicable to short sections of conduit used for the protection of exposed wiring from mechanical injury. These rules are applied in Chicago, where they have been found to work out satisfactorily.

Central Station Service

A Department Devoted to Commercial Policy and Management Topics, Including Methods of Increasing the Use of Electric Light, Power and Heat

Twenty-seven Systems Each Had an Output of 400,000,000 Kw.-hr. in 1919

IN 1915, when operating conditions and the demand for energy were still on a normal peace basis, there were but nine generating systems having a yearly output of more than 400,000,000 kw.-hr., while in 1919, when demand for energy had returned again to a peace basis, there were twenty-seven systems whose yearly output exceeded that figure. This information is reflected in the tabulation on page 1099 of this issue, which gives the peak load, date of its occurrence, yearly kilowatt-hour output and load factor of the largest generating systems in America for 1917, 1918 and 1919. Statements by officials of the power companies which have been made in transmitting the data for the past year reflect a steadily increasing demand for energy which they are finding some difficulty in satisfying.

Companies operating in various sections of the United States and in Canada are experiencing a power shortage. In commenting on this situation, F. A. Gaby, Toronto, Ontario, chief engineer of the Ontario Power Company of Niagara Falls, writes: "As to the power situation in the Niagara district, a serious shortage still exists. The recovery of industry since November, 1918, has been phenomenal, some 80,000 hp. previously used by munitions plants being absorbed entirely in the manufacture of other products. We have on hand requests for the delivery of about 45,000 hp., and at a conservative estimate, 100,000 hp. will be required to meet the growing demand."

John L. Harper, vice-president and chief engineer of the Niagara Falls (N. Y.) Power Company, states that although that company has put in operation the three 32,500-kva. units in the new extension of its plant No. 3, there is still a shortage of supply which will not be met even by total rating of these new units. "Should legislation make possible further advances in development," writes Mr. Harper, "it would probably require five years' constant construction work on the American side to place ourselves in position to meet the requirements for power delivery."

"The power situation is very active," writes F. J. Sill, superintendent of distribution of the New England Power Company, which has an extensively interconnected hydro-electric and steam system. "All of the present power users are increasing their load, and the company is not in a position at the present time to take on a load greatly in excess of that already contracted for."

Companies operating in New York, Chicago, Philadelphia, Detroit, Pittsburgh, Newark and Brooklyn, where a highly diversified load is served, show consistent growth in output. Many companies which at the beginning of the year anticipated a serious falling off due to loss of power load in munitions plants find that their output has materially increased. They have accounted for this largely by the fact that a large number of comparatively small power users were added, isolated plants being abandoned in favor of purchased power. In addition to this, not a small percentage of increased output is due directly to increases in residential demands and commercial lighting business.

Hydro-electric companies in California have been seriously affected by water shortage, necessitating a larger proportion of steam generation. In the Northern and Northwestern States, where operating companies supplied comparatively few munitions plants, the increase in output shows a natural and healthy growth. Regarding conditions in that section, W. N. Ryerson, general manager of the Great Northern Power Company, Duluth, Minn., says: "We did not undergo rapid expansion in this section, but have experienced a steady growth in our business, which, if anything, has been more marked since the signing of the armistice."

It is evident from an examination of the output of the various systems during the past three years that there is a general and rapid increase in the demand for energy, and the shortage of power in many localities emphasizes the urgent necessity for the construction of extensions to existing stations and the building of new plants where the ultimate rating of present stations has been reached. This is true in Canada as well as in the United States. Julian C. Smith, vice-president of the Shawinigan Water & Power Company at Montreal, says: "The Province of Quebec has encouraged the development of water powers, and as a result we were able at the beginning of the war to take care of the situation so that in this district there was no power shortage throughout the whole of the war. We feel now that the time has come to look forward to new developments, and soon, with the gradual improvement in financial conditions and the lessening of the industrial unrest, the new water-power projects will have to be carried out."

This year the table includes the outputs of electric railway companies generating over 100,000,000 kw.-hr. annually. A large amount of energy in some cases is purchased from power companies whose outputs are already reported in the table, therefore only those railway companies generating over 100,000,000 kw.-hr. in their own plants are reported. The total energy generated in 1919 by the forty-seven lighting and power companies included in the table was 24,862,460,942 kw.-hr., or 64.4 per cent of 38,559,000,000 kw.-hr., the total annual output of all central stations during the year. The total energy generated in 1919 by the eight railway companies was 2,473,098,444 kw.-hr.

Data on Output and Load Factor of Largest Generating Systems in America

(This table includes all lighting, power and electric railway companies in the United States and Canada having yearly outputs in excess of 100,000,000 kw.-hr.)

System	1919				1918				1917			
	Peak Load (Kw.)	Date of Peak Load	Yearly Output (Kw.-Hr.)	Yearly Load Factor (Per Cent)	Peak Load (Kw.)	Date of Peak Load	Yearly Output (Kw.-Hr.)	Yearly Load Factor (Per Cent)	Peak Load (Kw.)	Date of Peak Load	Yearly Output (Kw.-Hr.)	Yearly Load Factor (Per Cent)
Lighting and Power Companies:												
Niagara Falls Power Company	275,803	Dec. 29	2,034,608,904	84.2	254,139	Apr. 8	2,054,360,080	92.21	152,340	Aug. 1	1,188,221,770	88.97
Commonwealth Edison Company	428,630	Dec. 15	1,628,340,000	44.6	400,010	Dec. 2	1,508,070,000	43.5	392,330	Dec. 28	1,488,080,000	44.6
New York Edison and United Electric Light & Power Company	330,210	Nov. 25	1,104,521,883	38.5	286,103	Dec. 11	958,878,156	38.2	278,097	Dec. 12	954,913,584	39.2
Shawinigan Water & Power Company	172,900	Jan. 14	1,031,111,695	68.0	136,800	Sept. 24	1,058,136,117	.....	119,000	Dec. 21	633,573,610	60.4
Southern California Edison Company	200,020	July 23	1,021,977,519	58.3	163,125	July 12	779,758,000	54.5	166,755	Oct. 11	685,416,000	54.4
Pacific Gas & Electric Company	187,135	Dec. 19	994,557,418	60.7	166,705	June 4	922,037,604	63.1	158,272	Nov. 27	854,099,030	61.6
Ontario Power Company	150,000	Nov. 12	949,223,500	71.3	119,000	Oct. 19	963,845,200	92.4	123,500	Nov. 11	990,086,100	91.5
Detroit Edison Company	210,000	Dec. 5	872,583,200	47.4	172,000	Dec. 13	773,876,700	51.3	152,300	Nov. 27	672,200,600	50.4
Montana Power Company	133,500	June 13	865,998,552	74.0	157,800	Nov. 21	1,108,125,350	.....	147,712	Jan. 11	947,732,014	73.0
Montreal Light, Heat & Power Company	164,415	Dec. 16	852,680,550	59.2	166,730	Dec. 6	976,462,529	68.0	152,665	Nov. 12	946,832,817	70.8
Public Service Electric Company	207,890	Dec. 16	821,355,239	45.1	185,738	Dec. 5	795,481,279	48.9	181,500	Nov. 27	734,665,649	46.2
Philadelphia Electric Company	199,247	Dec. 18	722,615,280	41.4	166,294	Dec. 6	693,447,962	47.6	148,931	Nov. 20	600,583,589	46.0
Duquesne Light Company	157,900	Dec. 22	623,000,000	45.0	141,000	Dec. 6	641,874,585	51.9	125,000	Nov. 9	592,575,925	54.0
Southern Power Company	196,500	Dec. ..	585,596,925	.....	162,600	Dec. ..	551,313,367	.....	166,300	May	563,533,763	.....
Mississippi River Power Company	113,450	Nov. 18	590,488,000	59.4	102,950	Mar. 8	557,200,000	61.8	86,400	Oct. 31	476,500,000	63.0
Cleveland Electric Illuminating Company	153,878	Dec. 5	576,131,649	43.0	128,319	Nov. 22	543,663,042	48.33	113,228	Nov. 27	444,735,309	45.0
Toronto Power Company	115,000	Jan. 8	548,477,616	54.4	125,000	Dec. 3	897,512,877	81.9	118,000	Dec. 14	800,638,000	84.0
Pennsylvania Water & Power Company	87,000	Nov. ..	512,138,100	67.2	89,000	Feb. ..	500,641,122	64.2	86,000	.....	516,891,000	68.6
Buffalo General Electric Company	106,500	Nov. 22	508,583,680	54.5	104,100	Nov. 22	587,761,870	64.4	95,400	Dec. 6	440,596,100	52.7
Utah Power & Light Company	79,725	Jan. 14	461,532,000	65.9	81,313	Dec. 27	533,044,000	74.83	79,011	Dec. 21	502,183,000	72.5
Consumers Power Company	108,847	Nov. 28	456,230,164	47.8	98,666	Nov. 21	404,412,000	46.8	94,235	.....	380,570,917	46.0
Great Western Power Company	84,860	Aug. 1	453,353,358	60.9	75,480	Aug. 12	451,309,000	68.0	74,900	Oct. 6	457,998,635	71.13
Puget Sound Power & Light Company	93,900	Dec. 18	452,209,000	55.0	88,230	Dec. 20	427,800,000	55.4	83,800	Dec. 21	396,600,000	54.0
Tennessee Power Company	82,300	Feb. 14	422,272,590	58.6	87,800	Dec. 11	519,959,383	67.6	85,200	June 15	547,945,475	73.41
Electric Company of Missouri and Union Electric Lt. & Pr. Co.	99,498	Dec. 3	408,920,575	46.6	92,000	Nov. 26	395,820,236	49.1	92,300	Dec. 6	376,891,756	46.5
Consolidated Gas, Elect. Lt. & Pr. Co., of Baltimore	80,640	Dec. 5	392,201,280	54.9	82,760	Nov. 7	433,196,550	64.9	69,980	Dec. 4	343,523,580	62.4
New England Power Company	93,860	Dec. 9	357,303,224	43.5	76,900	Dec. 16	323,127,784	48.0	71,500	Oct. 30	300,600,000	48.0
Alabama Power Company	83,100	Jan. 10	347,993,284	47.7	86,850	Dec. 19	392,247,862	51.5	58,250	Nov. 14	289,715,125	56.7
Minneapolis General Electric Company	72,745	Oct. 24	332,264,401	53.2	66,189	Nov. 1	297,443,050	53.3	54,940	Dec. 6	222,146,210	46.16
Wisconsin Edison Company and Milwaukee Electric Ry. & Lt. Co.	97,912	Dec. 4	331,874,192	39.0	87,855	Nov. 20	327,784,516	43.0	71,106	Nov. 30	275,966,740	44.0
Edison Electric Illuminating Company of Boston	103,136	Dec. 8	328,798,850	36.4	95,774	Dec. 6	293,966,604	35.0	83,966	Dec. 19	265,430,474	36.1
Brooklyn Edison Company, Inc.	105,400	Jan. 15	327,084,075	35.4	86,000	Dec. 11	282,424,822	37.5	78,000	Dec. 19	255,912,300	37.5
Sierra & San Francisco Power Company	57,597	July 20	272,602,349	54.0	52,634	July 16	246,759,842	53.7	45,270	Jan. 11	196,069,588	49.44
Portland Railway, Light & Power Company	56,300	Dec. 22	271,600,300	55.0	56,900	Dec. 23	258,424,940	52.0	50,620	Dec. 31	218,086,315	49.0
Michigan Northern Power Company	35,794	Apr. 23	264,272,468	84.3	33,519	Dec. 24	233,381,654	79.4	32,990	Dec. 3	221,538,757	76.7
Georgia Railway & Power Company	71,700	Dec. 18	262,834,541	41.8	68,000	Nov. 8	238,489,012	.....	78,200	Apr. 24	258,607,882	.....
Washington Water Power Company	63,220	Dec. 3	241,761,350	43.6	33,956	Nov. 26	195,628,500	65.1	36,707	Dec. 20	188,311,100	58.5
Great Northern Power Company	48,000	May 12	213,189,992	50.7	45,780	.....	180,040,171	44.9	40,000	Oct. 24	180,583,920	51.5
Potomac Electric Power Company	55,000	Dec. 17	204,008,647	42.3	48,000	Dec. 20	173,180,014	41.0	44,800	.....	140,762,646	36.09
Toledo Railway & Light Company	48,220	Dec. ..	199,771,799	47.4	40,305	Dec. 4	161,103,970	45.7	37,627	Dec. ..	162,061,232	49.4
Rochester Railway & Light Company	42,500	Dec. 2	172,892,249	46.0	52,300	Nov. 22	196,171,300	42.8	42,154	Dec. 13	162,490,264	44.0
Southern Sierras Power Co. and Nevada-California Power Co.	29,200	.....	165,782,785	64.7	28,200	Aug. 6	161,347,690	65.3	25,900	Aug. 9	148,267,885	65.3
Narragansett Electric Lighting Company	57,000	Dec. 23	155,678,890	31.2	45,000	June 20	150,028,780	38.1	33,500	Dec. 19	113,238,441	38.6
Adirondack Electric Power Company	39,500	Dec. 23	144,553,094	41.8	50,250	Nov. 8-Ja.23	174,567,275	39.6	42,000	Dec. 7 & 14	158,570,164	43.1
Empire District Electric Company	32,030	Oct. ..	130,114,100	46.3	25,400	Sept. 5	114,446,685	51.4	23,000	Apr. 1	105,487,860	52.4
Virginia Railway & Power Company	42,800	Dec. 18	125,840,000	48.4	35,700	Dec. 18	164,810,750	52.8	37,000	Dec. 8	153,128,026	47.39
Southwestern Power & Light Company	53,034	Dec. 18	121,431,280	45.4	38,100	Sept. 26	148,562,000	44.5	31,500	Nov. 17	126,396,800	46.0
Electric Railway Companies:												
Interborough Rapid Transit Company	239,940	Dec. 19	810,158,475	38.5	204,000	Dec. 30	731,058,965	40.8	184,000	Dec. 11	689,665,975	42.8
Brooklyn Rapid Transit Company	111,000	Dec. 16	406,130,443	41.7	109,892	Feb. 21	385,346,075	40.0	115,792	Feb. 2	396,068,887	39.0
Philadelphia Rapid Transit Company	101,120	Dec. 18	349,542,666	39.4	94,730	Dec. 27	339,232,739	40.8	103,220	Jan. 11	348,372,056	38.5
Boston Elevated Railway Company	71,760	Mar. 23	240,429,915	38.3	67,965	Mar. 23	228,131,265	38.4	79,535	Feb. 12	262,920,065	37.7
Kansas City Railway Company	49,430	Oct. 27	211,707,571	49.0	57,280	Jan. 11	209,378,747	41.7	61,350	Feb. 2	236,675,814	44.0
Pennsylvania Railroad, Long Island City Power Plant	53,900	Dec. 19	181,017,940	34.2	48,600	Jan. 3	165,377,180	36.3	45,000	Dec. 10	161,673,710	37.5
New York Central Railroad Company	44,100	Dec. 29	140,435,406	36.3	38,360	Jan. 22	127,412,457	37.9	42,480	Dec. 10	147,809,842	39.7
Twin City Rapid Transit Company	42,612	Nov. 28	133,676,028	35.8	44,966	Feb. 19	131,351,288	33.4	51,956	Mar. 31	152,469,348	33.5

Digest of Electrical Literature

Including Brief Abstracts of and References to
Important Articles Appearing in the Scientific and Engineering Press
of the World

Generators, Motors and Transformers

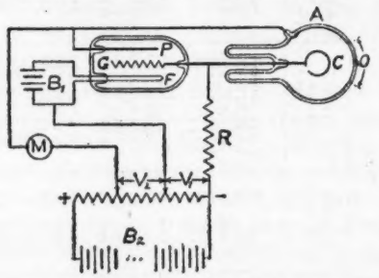
The Alternating-Current Commutator Motor.—B. G. LAMME.—The alternating-current commutator motor has been developed principally for the purpose of obtaining adjustable or variable speeds. In general control of speed with the alternating-current induction motor implies variable or adjustable frequency in some form, and this in turn involves a commutator of some type. The simplest method, according to the author, for viewing both alternating-current and direct-current commutating problems is to consider primarily the actual emfs. short-circuited by the brushes and the resistance in the short-circuited paths—that is to say, the problem of commutation is largely one of the permissible amount of short-circuited current. The author contends that the commutation problem in alternating-current motors is the same as for direct-current when all emfs. are taken into account. The major part of the paper covers the consideration of the different emfs. which should be taken into account in the various types of alternating-current commutator motors, and it is shown in a general way that the emfs. involved in speed control also appear in the commutation problem. In the latter part of the paper certain general conditions of commutation and brush operation are treated and some figures are given for comparison of alternating-current and direct-current commutating limits.—*Journal A. I. E. E.*, March, 1920.

Analysis of the Performance of Alternating-Current Machinery by Means of Vector Locus Diagrams.—LEON OTIS-CHEVALIER.—Certain developments in complex algebra lead the author to a number of theorems of high generality concerning the form and character of the performance diagrams for alternating-current machinery of various types. In this theory neither parasitic effects due to saturation nor iron losses is taken into consideration. As examples of the practical application of the vector locus analysis the cases of a single-phase series motor and a polyphase induction motor are treated. These cases are characterized by the well-known circular diagrams. The Latour compensated repulsion motor, which leads to the loci of parabolic and inversed parabolic form, is also discussed.—*Revue Générale d'Electricité*, March 6 and 13, 1920.

Lamps and Lighting

Glare Measurements.—WARD HARRISON.—Data are presented showing the range of agreement in opinion among a number of observers as to the glare from bare lamps and other more diffuse light sources in comparison with a reference source of variable intensity. The practicability of a rough classification of lighting installations into groups according to the sensation of glare as registered by small instruments based on this method of comparison is discussed.—*Transactions Illuminating Engineering Society*, Feb. 10, 1920.

A Photoelectric Photometer.—ARTHUR H. COMPTON.—In this paper the difficulties are reviewed which heretofore have prevented the use of the photoelectric cells in routine photometry. The use of a thermionic amplifier to increase current readings is suggested, also a filter to reduce the proportion of blue light and render the indications proportional to the photometric value. With such equipment lamps are compared by varying



ARRANGEMENT OF THERMOELECTRIC CELL FOR PHOTOMETRY

their distances to the cell until the deflection of the galvanometer is the same as that given by the standard lamp. In the illustration the amplifier is indicated by *CGF* and the inner electrode *C* is used as the photosensitive cathode.—*Transactions Illuminating Engineering Society*, Feb. 10, 1920.

Generation, Transmission and Distribution

Savings Due to Economizer.—R. G. BOHN.—Methods are given for calculating the heat transfer, final temperatures of water and gas and the net savings effected.—*Power Plant Engineering*, April 1, 1920.

The Electrical Problem of Victoria.—In 1918 a committee was appointed by the government of Victoria, Australia, to formulate advice regarding the use of brown coal for power and other purposes. This committee recommended that the brown-coal deposits at Morwell should be utilized to generate electrical energy and that the current should be transmitted to Melbourne for distribution. At present coal from New South Wales is imported into Victoria to the extent of about 450,000 tons per annum, and it is suggested that this quantity should be displaced by the use of electrical energy generated from brown coal. After a careful consideration of the problem the commissioners have arrived at the following conclusions: (1) That the necessary steps should be taken to inaugurate a state scheme for the supply of electrical energy; (2) that as a nucleus of such scheme the Morwell brown coal field should be opened up and a powerhouse established of a capacity of 50,000 kw. for burning it; (3) that the scheme be undertaken with a view to operation early in 1923; (4) that the consideration of hydro-electric power schemes be deferred until further investigations. Other recommendations cover the problems involved.—*Electrical Times*, March 11, 1920.

Traction

Electrification of Steam Railways.—M. SEMENZA.—Previous to the war the electrification of steam railways in Italy was justified by the necessity of improving the traffic of some lines, too expensive for steam traction, or of increasing the traffic of others which had reached their maximum development with steam traction. After the war, however, a supplementary reason arose to justify the electrification, namely, that of limiting so far as possible the use of coal. The author shows how this economy can be obtained and what type of electric locomotive should be employed. His conclusion is in favor of the direct-current system of traction.—*Science Abstracts, Section B,* Dec. 30, 1919. (Abstracted from *Elettrotecnica,* Sept. 15, 1919.)

Modern Practice in the Construction and Maintenance of Rail Joints and Bonds in Electric Railways.—E. R. SHEPARD.—This revised edition of a paper already published on the subject contains an appendix with descriptions of recent improvements in the field of rail bonds and joints not contained in the former article.—*Technologic Paper No. 62, U. S. Bureau of Standards,* Feb. 9, 1920.

Installations, Systems and Appliances

Automatic Control for Motors Driving Pumps and Compressors.—B. W. JONES.—In the use of direct-current motors, squirrel-cage and slip-ring induction motors and synchronous motors for pump and compressor drive there are about eighteen variations in the systems employed for automatic control. Usually the direct-current motors are started on series resistors which are automatically short-circuited when the motor reaches a given speed. The author recommends the use of starting compensators for all alternating-current motors in this field and states that in practically every instance a simple one-point automatic compensator will give just as satisfactory results as a more complicated multi-point type. Wiring diagrams are given of automatic-control panels for a number of representative cases using motors of different types. Pressure regulation is usually accomplished by aid of a diaphragm, which, in a direct-current shunt motor, causes resistance to be cut into the field circuit when the pressure drops. Reversed action is desired when the motor is running a stoker. The diaphragm then is working from the forced-draft pressure, so that when the draft is increased the stoker increases in speed.—*Power,* March 30, 1920.

Electric Motors for Coal Mining.—FRANK BROADBENT.—In this article the author deals with means of increasing the output of the coal fields. He points out that this involves increased handling and transport facilities and a general speeding up of all other operations, including pumping, ventilating, hauling, winding, picking, screening, etc., and for all these purposes electricity is not only the most convenient but also the most economical method of driving.—*Beama,* January, 1920.

Electrically Driven Hoists.—FRASER JEFFERY.—Unbalanced single-drum hoisting and the more efficient balanced hoist employing a second cage or counterweight are considered. The character of load imposed by different types of hoist and different hoisting depths is shown by means of curves. It is said that the slip-ring induction motor is usually applied to this service. Details of electric braking and a comparison of full magnetic and liquid control are included.—*Power,* Feb. 24, 1920.

Electrophysics and Magnetism

Synthetic Electric Furnace Cast Iron.—CH. A. KELLER.—A description of the development in France during the war of electric furnace processes for converting steel turnings from munition plants into low-carbon cast iron, high in silicon and low in sulphur and phosphorus, for the production of cast-iron shells. Several types of furnaces were used, and the method was varied according to whether very low sulphur or very low phosphorus, or both, were desired.—Paper presented before American Electrochemical Society, April 10, 1920.

Telegraphy, Telephony and Signals

The Audion Oscillator.—R. A. HEISING.—The author covers the theory and operation of audion oscillator circuits, embracing phase relations in various circuits, frequency of operation, simplication of complex circuits and the behavior of oscillators as a function of the many variables. Vector diagrams are given of the phase relations in several simple circuits. The similarity of more complicated circuits to the simple ones is illustrated, and the method of determining the mode of operation of these complicated circuits by resolving them into simple ones is given. A series of curves shows the behavior of an oscillator as the six independent variables in the circuit are varied, and a method of quickly and easily adjusting a circuit to its proper working condition is pointed out.—*Journal A. I. E. E.,* April, 1920.

Determination of Damping and Frequency in Triode Circuits.—BLONDEL and LAVANCHY.—Some time ago A. Blondel published (*Journal de Physique,* July 1919) a general method for analyzing triode oscillator problems. This method consists briefly in a discussion of the "characteristic equation" derived from the differential equations of the system. Use is made of a certain general theorem, due to Hurwitz, regarding the conditions of existence of any root with a positive real component such as would correspond to an oscillation with increasing amplitude. In the present communication a résumé of this method is given, and as examples of the technical application of the analysis a number of practically important circuits are treated. The theory is flexible enough to embrace not only what Blondel calls the æolian condition—*i.e.,* when the reaction is just big enough to maintain steady oscillations of very small amplitude—but it permits also the computation of the damping of the system when these conditions are not reached.—*Revue Générale d'Electricité,* Dec. 20, 1919.

Miscellaneous

Oil as a Fuel from the Producer's Viewpoint.—HENRY THOMAS.—The world's production of petroleum in the year 1918 was 514,208,715 barrels of 42 gal., produced by the following countries in the order of their quantity as reported by the United States Geological Survey:

United States	355,927,716	Japan and Formosa	2,449,069
Mexico	63,828,327	Egypt	2,079,750
Russia	40,256,182	Trinidad	2,000,000
Dutch East Indies	12,846,265	Argentina	1,321,315
Rumania	8,730,235	Germany	711,260
India	8,000,000	Canada	304,741
Persia	7,200,000	Venezuela	190,080
Galicia	5,591,620	Italy	35,953
Peru	2,536,102		

The author discusses the use of petroleum as a fuel and oil-burning equipment both for marine and power plant use.—*Journal Engineers' Club of Philadelphia,* February, 1920.

TRANSPORTATION conditions continue to improve in general, although some distant localities in the South and the West have not benefited so far to any extent. Freight shipments in Chicago and the East are much better than heretofore, and the general belief is that all delayed freight now en route will be delivered to jobbers within the next few weeks.

DURING the past week one jobber in the metropolitan district received two cars of pipe and one car of flexible armored conductor from the Pittsburgh district, thus indicating that of the materials most badly needed some are commencing to come through in good quantity.

HEAVY demands for pipe, armored conductor, wire and porcelain for suburban building in all sections is reported, with a question as to whether shipments will continue to arrive in sufficient quantity to keep the building program going. So far immediate needs are being met.

ONE LINE of switchboxes has advanced 3 cents on each, and annunciator wire has been marked up 5 per cent by at least one large manufacturer. In addition, fittings for flexible armored conductor have been advanced by several manufacturers.

LOCAL stocks of pole-line materials are almost gone. Mills have plenty of cross-arms, but they cannot move them. Several carloads are en route to jobbers.

IT IS EXPECTED that books for third-quarter ordering of electric sheets are about to open, with little additional capacity over that of the first half year. No let-up in volume of ordering is expected.

FROM the present rate of ordering, electrical manufacturers will hang up new records this year. Business coming in is in excess of production capacity. Car shortage is backing up shipping schedules.

THERE will be no Chicago Electric Show in October of 1920 as had been planned, it being deemed poor business judgment to project a show just before the presidential election and at a time when business conditions in the country are so uncertain.

THE NEW Court of Industrial Relations established in Kansas has been declared constitutional by Judge Curran of the district court before which its legality was questioned.

NOTICEABLE progress in the industry and in its service to the public is announced in the second annual report of the advisory committee of the California Electrical Co-operative Campaign.

EVENTUAL success in fabricating ships by electric welding instead of riveting was confidently prophesied by speakers at meetings of the Philadelphia Section, A. I. E. E., and the American Bureau of Welding.

L. K. SHERMAN, president of the United States Housing Corporation, has been nominated for president of the American Association of Engineers, which convenes in St. Louis on Monday.

News in Brief

SUMMARY

of Important Happenings in the Industry During the Week

A SPECIAL session of the South Dakota Legislature is to be convened this month which will consider the proposal of the water-power commission of the state to dam the Missouri River for the purpose of furnishing hydro-electric power to the cities of the State and possibly also to Sioux City, Iowa.

TO PROMOTE the safety movement public utilities of New York State and Pennsylvania are organizing a "no accident week," to be observed during June 7-12 in industrial and manufacturing plants.

THE ANNUAL convention of the National Electric Credit Association will be held in New York City on June 17 and 18, with papers and discussions in which delegates from various cities and sections will participate.

APPRAISAL and valuation, power and combustion topics and the new elevator code will be discussed at the spring meeting of the American Society of Mechanical Engineers, to be held in St. Louis, May 24-27.

NEW JERSEY will receive this year from her franchise tax on public utility companies nearly $4,000,000, or approximately $1,000,000 more than last year.

THAT the electrical industry depends upon engineers for its commercial success was impressed upon undergraduates in a talk by Richard H. Rice of the General Electric Company before the Harvard Engineering Society.

TEN RECOMMENDATIONS for the guidance of electrical manufacturers who desire to exhibit at electrical shows and for the organization of such shows have been issued by the Electrical Manufacturers' Council.

A LOW-PRICED double-base device which allows simultaneous use from one socket of both a lamp and an appliance has been developed by E. O. Schweitzer, chief testing engineer of the Commonwealth Edison Company, Chicago.

AMONG resolutions passed by the United States Chamber of Commerce at its Atlantic City convention were one condemning the embarkation of the government in businesses that can be successfully conducted by private enterprise and one advocating the further development of the Bureau of Foreign and Domestic Commerce.

ORGANIZATION of the Council on Industrial Relations for the Electrical Construction Industry in the United States and Canada has been effected between the manufacturers and the brotherhood.

TO PERMIT a day's stop-over at Albuquerque, N. M., to view the Grand Canyon, the time for the departure from New York of the N. E. L. A. "Blue Special" has been advanced twenty-four hours, and the train will leave Thursday, May 13, arriving at Albuquerque on Sunday and at Pasadena Tuesday, May 18.

HYDRO-ELECTRIC plants which will effect a saving of $2,000,000 annually in fuel-oil costs alone are to be financed by the Pacific Gas & Electric Company, which is issuing $10,000,000 five-year gold notes at 7 per cent to meet the cost of construction.

IN A SUIT against the Quebec Railway, Light, Heat & Power Company, carried to the Judicial Committee of the British Privy Council, that body found the company negligent in that it had not grounded distribution lines which broke in a storm and caused fire to destroy customers' houses.

CHANGES made in the water-power bill by the Congressional conferees eliminate the provision that an engineer officer should be executive secretary of the federal commission, strike out the clause giving the government the option of redeeming sites where licenses are transferred, change to 100 hp. the maximum amount of capacity for which a license may be issued without charge to states and municipalities, change the language relating to charges, and strike out the provision that severance damages are not to exceed the actual expenses for maintenance.

News of the Industry

Chronicle of Important Events and General Activities in the Technical, Commercial and Manufacturing Fields With Announcements and Reports of Association Meetings and Conventions

Utilities Ask for 12 Per Cent Return Plus 4 Per Cent Reserve

THE difficulties of public utilities in raising money were ascribed primarily to politics, then to the high price of money, inadequate net earnings and lack of confidence on the part of the investing public by leading bankers and utility executives of Illinois at hearings held in Chicago on April 29 and in Springfield on May 3 before the full Public Utility Commission of the State. It was said that by the end of next year the Chicago utilities will need about $80,000,000, and the down-state companies will need almost as much more. new capital for essential betterments and improvements. Edgar S. Bloom, of Chicago, president of the Central Union Telephone Company, said that it was impossible for the utility companies to compete either in the money or the labor market with unregulated concerns, and Chairman J. H. Wilkerson of the commission said that the utility companies were facing what was generally conceded to be a serious situation. Utility companies which are among the strongest financially cannot get money without paying 9 per cent and then they must earn more. At the Springfield hearing W. H. Sawyer of the East St. Louis Light & Power Company said that public utilities must earn a 12 per cent rate of return and that they should earn a 4 per cent reserve in addition. It was the evident desire of the commissioners to find out why the public invests in industrial companies in preference to public utilities and what corrective measures could be employed by the regulating body to induce capital to flow into the public utility field. The witnesses gave as two of the reasons that public utilities are used for the aggrandizement of politicians and are not given the support they deserve by the daily press. Utilities are not allowed to earn a sufficient rate of return to provide what investors consider an adequate margin of safety after all operating, depreciation, dividend and interest charges have been met. Furthermore the relief given to a utility in financial straits is usually so long delayed that investments in the property are often put in jeopardy.

The Big Pasadena Convention in a Nutshell

Convention opens in the Hotel Huntington, Pasadena, Cal., Monday evening, May 17, with the president's reception; first general session the following morning.

Four general sessions, one each morning for the first four days of the convention, and eight afternoon sectional meetings, two in one afternoon and three each in two other afternoons, together with ten committee meetings, comprise the business program.

Entertainment features for every day and every evening have been arranged.

During the business sessions there will be eleven addresses of fifteen minutes each.

There will be eighty-one reports and papers presented.

The full text of fifty-three of these papers and reports has been printed.

These reports and papers average seventeen printed pages, 8 in. x 10½ in., or a total of 901 pages.

Each page contains 120 lines, averaging nine words each, or a total of approximately 900,000 printed words, exclusive of space occupied by cuts or graphs illustrating the reports or papers.

Two special trains will leave the East for the convention and one from the Pacific Northwest, and special cars will go from Illinois, Missouri, Kansas, Nebraska and Texas.

More than 2,950 reservations have been made, indicating an attendance of 3,500 to 4,000.

Every large central station in the country will be represented.

Water-Power Conference Report Passes House with Large Majority

ADOPTION of the conference report on the water-power bill was carried by the House of Representatives by 259 to 30. The large vote in the House is regarded as an indication that the Senate will adopt the report by an even more decisive majority.

A summary of the changes made by the conferees in the bill follows:

Instead of an engineer officer as executive secretary of the federal power commission it was provided that the commission "may" request the services of an engineer officer whose duties would be prescribed by the commission.

In the definition of "navigable waters" slight changes were made in the wording to indicate that interruptions by falls or shallows would be "between the navigable parts of such streams or waters."

In that portion of the law providing for the determining of the net investment of a licensee in any project, the conferees inserted the word "legitimate" in defining the costs.

The conferees struck out entirely the proviso with regard to securing the consent of the Indian tribe and also struck out the provision that the commission is to investigate the utility of tunnels in studying storage and conservation.

The Potomac power development was eliminated.

In the matter of transferring licenses the provision that the United States was to have the option to redeem such sites was stricken out.

In the matter of charges the conferees eliminated the language appearing in the bill and provided that the licensee shall pay charges to the United States until the states shall make provision for preventing excessive profits or for the expropriation thereof to themselves, or until the period of amortization as provided is reached.

The conferees changed to 100 hp. the maximum amount of horsepower capacity for which a license may be issued without charge to states and municipalities.

The entire paragraph (j), regarding discrimination in favor of any municipality as against other users, was eliminated.

In regard to the construction of locks to maintain the needs of navigation the conferees provided that the commission "may grant the application with the provision to be expressed in the license that the licensee will install the necessary navigation structures if the government fails to make provision therefor within a time to be fixed in the license."

The provision that severance damages are not to exceed the aggregate actual expenses or loss for maintenance, etc., was stricken out.

Section 17 of the bill, pertaining to distribution charges, was rewritten.

The law providing for the Newlands waterway commission was repealed, as had been provided in the House bill. The Senate amendment to the waterways commission proposal was stricken out. The conferees also struck out the final paragraph of the Senate bill, providing for non-interference with river and harbor projects.

New 300,000-Kw. Station of Unique Design for New York City

TO MEET the growing requirements for electric service in New York City the United Electric Light & Power Company will construct a generating station of 300,000 kw. ultimate capacity. Approximately six acres of land situated on the East River between 132d and 134th Streets, in the Bronx, have recently been acquired by the United company on which it will erect the new plant, to be known as the "Hell Gate station." Present plans provide for steam pressure of 250 lb. (17.5 kg.) at the turbine throttle and approximately 200 deg. normal superheat.

Departures from the usual central-station design are found in the plans of the new station: The turbine room will be built along the river front and the boiler house immediately adjoining. This will eliminate the massive and costly construction work involved in building the conventional type of intake tunnel. The inlet pipes for the circulating pumps will practically have the suction ends in the river. Stationary screens will extend approximately the full length of the station and will provide enormous screening area in comparison with older type stations. The discharge tunnel will be built as part of the foundation work and opened to the river at each end instead of having only one discharge opening as is usually the case. Provision is being made for storing coal immediately adjacent to the station and a flexible coal-handling equipment will be installed. A building adjoining the main station will provide adequate quarters for offices and employees.

The construction of the bulkhead and wharf has been started, and it is expected that the station will be placed in operation during the fall of 1921. A more complete description will be given in the ELECTRICAL WORLD later.

High Special Service Record for Society for Electrical Development

IN SPITE of all handicaps the Society for Electrical Development rendered more special services to members during the past year than in any previous year, according to the statement of J. M. Wakeman, general manager, in his report at the society's annual meeting, held in New York at the Engineers' Club on Tuesday. Almost every member called for such service during the year, it was stated. Particular attention was called to the work of the society in the education of the public.

The following directors were elected to serve four years each: W. W. Freeman, E. W. Rockafellow, L. A. Osborne, Earnest McCleary and James H. McGraw. At the board meeting, held immediately after the annual meeting, a budget for the ensuing year was decided upon, which provides for carrying on all the work of the society, including an "electrical Christmas" campaign.

The following officers were elected: President, W. W. Freeman; vice-presidents, Anson W. Burchard, Joseph E. Montague, Fred Bissell, James R. Strong and J. Robert Crouse. General Manager J. M. Wakeman and Secretary-Treasurer James Smieton, Jr., were reappointed. Charles L. Edgar accepted appointment as chairman of the executive committee and announced his intention to call bi-monthly meetings of this committee to give close attention to the important matters coming up for consideration and obtain for the electrical industry the full benefit of the great work the society is carrying on. The other members appointed upon the executive committee were Joseph E. Montague, L. P. Sawyer, W. D. Steele, E. W. Rockafellow, Fred Bissell, James R. Strong, Fred B. Adam and J. Robert Crouse, with President Freeman a member ex officio.

Industrial Relations Council of Brotherhood and Contractors Effected

ORGANIZATION of the Council on Industrial Relations for the Electrical Construction Industry in the United States and Canada was effected by the representatives of the National Association of Electrical Contractors and Dealers and the International Brotherhood of Electrical Workers at a meeting held in New York on April 30. While the primary purpose of the two member organizations is to remove causes of friction and dispute, the council conceives its principal function to be that of study and research so that it may act with the fullest knowledge of the causes and so that it may secure the largest possible measure of genuine co-operation between the member organizations, and generally between employers and employees, for the development of the industry as a servant to society and for the improvement of the conditions of all engaged in it.

The council consists of five members from each organization. These members may be withdrawn on four months' written notice. All meetings of the council, it is provided, should be open to the public. The council shall interpret the declaration of principles adopted by the two member organizations.

In the adjustment of disputes the council is pledged to adopt the following procedure:

When a dispute arises which cannot be adjusted by the existing local machinery, and notice to that effect is re-

ceived by the secretary of the council from either of the parties to the dispute, the secretary of the council after investigation may, if circumstances warrant, request each side to submit the dispute to a board of conciliation, to be composed of two representatives from each side, parties to the dispute, and one representative to be selected by the council who shall act as chairman but cast no vote.

The appointment of representatives by the parties to the dispute to act for them on the board of conciliation shall constitute a voluntary agreement between the parties to accept as an effective agreement between them the unanimous decision of the board of conciliation.

If the board of conciliation does not reach an agreement, it shall make a finding of the material facts and state the reasons why it has been unable to reach an agreement. The chairman shall report such finding and statement to the council and the council shall determine the matters so submitted as arbitrator. If the council reaches a unanimous agreement, it shall report its decision back to the board of conciliation through its chairman, and the board shall then state the agreement between the parties to the dispute, the same as if the board itself had reached a unanimous decision. If the council shall fail to reach a unanimous decision, it shall make majority and minority reports and transmit these to the chairman of the board of conciliation, who shall immediately publish them in order to inform the public of the material facts and the reasons why the council has been unable to reach an agreement.

Departure of N. E. L. A. Blue Special Advanced One Day

TO ALLOW a stop-over of one day at the Grand Canyon of Arizona the time of departure of the "Blue Special" via the New York Central from New York for the convention of the National Electric Light Association at Pasadena has been advanced to Thursday, May 13. The special train will thus be one day earlier than stated in the original schedule. It will arrive at Albuquerque Sunday, May 16, instead of Monday, and will lie over twenty-four hours, permitting a visit to the Grand Canyon. The train will leave Albuquerque Monday, May 17, at 12:45 p.m. and reach Pasadena Tuesday, May 18, at 5 p.m., as in the original schedule.

Owing to this change so many additional reservations have been received for the "Blue Special" that it will be run in two sections. The "Pink Special," which was to leave via the Pennsylvania Railroad from New York, has been abandoned, but three special cars will be attached to a scheduled train.

New Jersey Utilities to Pay Record Tax Levies

PUBLIC utilities of New Jersey will pay this year the largest amount of money in franchise taxes ever collected by the municipalities of that State. The figures given out by the State Board of Taxes and Assessment show that a total tax of $3,925,744.42 will be received from nineteen street railways, 110 water, seventy-five gas and electric, thirty-three telegraph and telephone, three district telegraph messenger, seventeen sewer, and seventeen sewer and pipe line utilities. This is an increase of $934,078.28, or 31.2 per cent over last year's tax. Several reasons are given by the board for the increase. This is the first assessment that has been levied at the maximum rate of 5 per cent of the gross receipts as a result of the passage of the 1917 law. Previous to that year the assesment was made at the rate of 2 per cent of the gross receipts, but under this law the rate was raised 1 per cent annually until a maximum of 5 per cent was reached. Utility companies whose annual gross receipts are below $50,000 are still taxed at the rate of 2 per cent. Another reason for the growth in this tax, it is stated, is that in all public utility activities increases in rates have been allowed, resulting in increased gross receipts.

It is interesting to note that gas and electric utilities will pay $1,970,812.82, or over 50 per cent of the total assessments. The tax is based on the gross receipts for the year ended Dec. 31 last.

The Pasadena N. E. L. A. Convention Day by Day

TUESDAY, MAY 18

Meeting Accounting Section's executive committee, 7:30 p.m.

Meeting Commercial Section's executive committee, 7:30 p.m.

Meeting Electric Vehicle Section's executive committee, 7:30 p.m.

Meeting Technical and Hydro-Electric Section's executive committee, 7:30 p.m.

President's reception, 8:30 p.m., ballroom, meeting room No. 1.

WEDNESDAY, MAY 19

First general and executive sessions, 9:30 a.m., ballroom, meeting room No. 1.

Meeting and luncheon, 1 p.m., national executive committee, private dining room, first floor.

Motion picture of convention delegates, 2 p.m., front porches and grounds of the Hotel Huntington. These pictures will be shown on Thursday evening at public policy committee session.

Special meeting Commercial Section, 2:15 p.m., ballroom, meeting room No. 1.

First Commercial Section session, 2:30 p.m., ballroom, meeting room No. 1.

Special meeting Technical and Hydro-Electric Section, 2:15 p.m., meeting room No. 2.

First Technical and Hydro-Electric Section session, 2:30 p.m., meeting room No. 2.

California mission play and entertainment, evening.

THURSDAY, MAY 20

Second general and executive session, 9 a.m., ballroom, meeting room No. 1.

Meeting and luncheon, 1 p.m., public policy committee, private dining room, first floor.

Special meeting Accounting Section, 2:15 p.m., meeting room No. 3.

First Accounting Section session, 2:30 p.m., meeting room No. 3.

Second Commercial Section session, 2:30 p.m., meeting room No. 2.

Second Technical and Hydro-Electric Section session, 2:30 p.m., ballroom, meeting room No. 1.

Public policy committee session, 8:30 p.m., ballroom, meeting room No. 1.

FRIDAY, MAY 21

Third general and executive session, 9 a.m., ballroom, meeting room No. 1.

Second Accounting Section session, 2:30 p.m., meeting room No. 3.

Electric Vehicle Section session, 2:30 p.m., meeting room No. 2.

Third Commercial Section session, 2:30 p.m., ballroom, meeting room No. 1.

"Big Night!" tendered by Pacific Coast Section.

SATURDAY, MAY 22

Fourth general and executive session, 9 a.m., ballroom, meeting room No. 1.

John I. Beggs Again Active in Milwaukee Utility Management

JOHN I. BEGGS, well-known public utility operator of Wisconsin, is expected again to assume active control of the Milwaukee Electric Railway & Light Company, over which he presided some nine years ago. He has continued to be a director of the company and is now chairman of an executive committee which has largely directed the affairs of the company since President J. D. Mortimer resigned. It has been proposed to create the position of chairman of the board of directors on condition that Mr. Beggs would accept the position.

In speaking on the subject to a representative of the ELECTRICAL WORLD, Mr. Beggs said that if he accepted the appointment he would maintain the company's present organization as it is and would apply himself particularly to the solution of the company's public policy problems and to finding ways and means of raising the $10,000,000 which the company needs this year.

The election of a new president is not being considered just now. If Mr. Beggs becomes chairman of the board of directors, he plans to perform also the duties of president, at least for the present.

Manufacturers' Council Recommendations on Electrical Shows

RECOMMENDATIONS on electrical shows and exhibits have been made by the Electrical Manufacturers' Council as a guide to all electrical manufacturers to encourage a high standard in electrical shows and to stimulate management and exhibitors to maintain such a standard. This, it is stated, is especially important because of the expense which such shows involve, the difficulties of transportation and the desirability of conserving labor and materials.

The recommendations follow:

For the fullest co-operation, it is strongly recommended that exhibitors as a whole shall have representation in the management of the show equal to that of the local management.

Class and nature of exhibits shall be determined by the show management. Concessions for sale of knicknacks, candy, toys, etc., shall be prohibited as they detract from the education value of exhibits.

Souvenirs represent waste and extravagance of a character which the industry is trying to prevent. They are not beneficial in promoting the main educational object of shows. Their distribution at shows shall therefore be prohibited.

Exhibitors shall not be asked to give financial support through advertisements or in any other way to programs and catalogues. These, if issued, shall not contain any advertisements.

Passes shall be issued to officers, official representatives and attendants of companies exhibiting, the number to be based equitably on the space occupied.

Exhibitors may have trade tickets at one-half the regular admission price, settlement to be made on the basis of the tickets actually turned in at the gate.

The show management shall strive to make the character of the exhibit such as will reflect credit upon the electrical industry and at the same time keep the expense within reasonable limits. Any surplus after payment of legitimate expenses shall be returned to exhibitors in proportion to the amount of space used.

The show management shall have the right to discontinue and remove any exhibit which in its opinion is objectionable to exhibitors, the public or the industry.

For the amount paid for space the show management will provide the following service to exhibitors: Insurance against fire and theft; reasonable protection against fire and theft; watchman day and night; clean aisles and thoroughfare (not including exhibits). Store boxes and other containers in good order and at the proper time deliver them promptly to exhibitors for return shipment.

It is recommended that, before contracting for space or otherwise committing themselves to participate in an electric show or exhibit, all electrical manufacturers ascertain from the secretary of the Electrical Manufacturers' Council if the management thereof has adopted the foregoing recommendations.

Chamber of Commerce Again Favors Private Ownership

INCREASED production was the keynote of the convention of the Chamber of Commerce at Atlantic City in the week of April 26, in which leading topics were the relation of labor to the problem of increased production and the need of leadership for labor which recognizes its responsibility both to the workers and to the public; the broad question of financing the industrial needs of the world, and the several detailed problems of taxation, accounting, transportation, domestic distribution and the ownership of public utilities.

Several speakers representing different branches of industry spoke on the labor situation. Matthew Woll, vice-president of the American Federation of Labor, said that it was labor's point of view that if the right to strike was made illegal the force behind the labor organization would be removed and the opportunity for labor to progress thwarted. Governor Allen of Kansas pointed out that the method of settling labor difficulties in the utility field by an industrial court, such as has been established in his state, substituted a court of justice for a compromise. He said that labor had the same rights as capital in this court and that the public voice was also heard. He emphasized the fact that the court was not against labor or labor unions but against the present system of union leadership, and that an industrial court organized in each state would make unnecessary the present system of labor organization in order for labor to maintain its rights. Dr. Charles A. Eaton emphasized the need for better management as well as better labor in the present situation.

James H. McGraw, representing the business press at the general session, called attention to the educational value of the business press in placing ideas before industry and maintained that the present condition of decreased production was due largely to a state of mind. He showed how the business press, by making possible an interchange of thought between thousands of men in industry, had become a great educational force at work on the problems of the present day.

The convention went on record against government ownership of public utilities. From the presidential address at the opening of the convention to the final adoption of resolutions, whenever this question came up there was most emphatic support for the principle of private ownership and private operation, not only in railroads and local public utilities but also in shipping and the merchant marine as well. This matter was deemed so important that the committee on resolutions was unanimously supported in its recommendation that the meeting reiterate its declaration from the previous annual meeting to the effect that there should be placed "upon the individual only that degree of restraint which shall prevent his encroachment upon the rights of others."

Resolutions concerning industrial courts, public service corporations and other subjects were referred to the board of directors for further consideration and possible submission to a referendum.

South Dakota Legislature to Consider State Water-Power Project

A SPECIAL session of the South Dakota Legislature is to be called by the Governor about the middle of this month to deal with a number of important matters awaiting action. Among these is the question of state water-power development by the construction of a dam on the Missouri River. This project has been under investigation by a water-power commission which is said to have finally selected a site for the dam and to be about to ask the Legislature for an appropriation.

Effect of Being Creditor Nation Is Foreign Trade Convention Theme

DURING the past few years the relation of the United States to foreign trade has undergone a marked change, leaving this country in the creditor class of nations, and it is this situation that has been taken as the theme of the seventh national foreign trade convention, to be held May 12-15 in San Francisco.

The general sessions, which will be held each morning and Wednesday afternoon, will take up in order the following topics: (1) "Fundamentals of Our Foreign Trade;" (2) "Exports and Imports;" (3) "Foreign Trade Policies;" (4) "The Merchant Marine;" (5) "National Program for Foreign Trade."

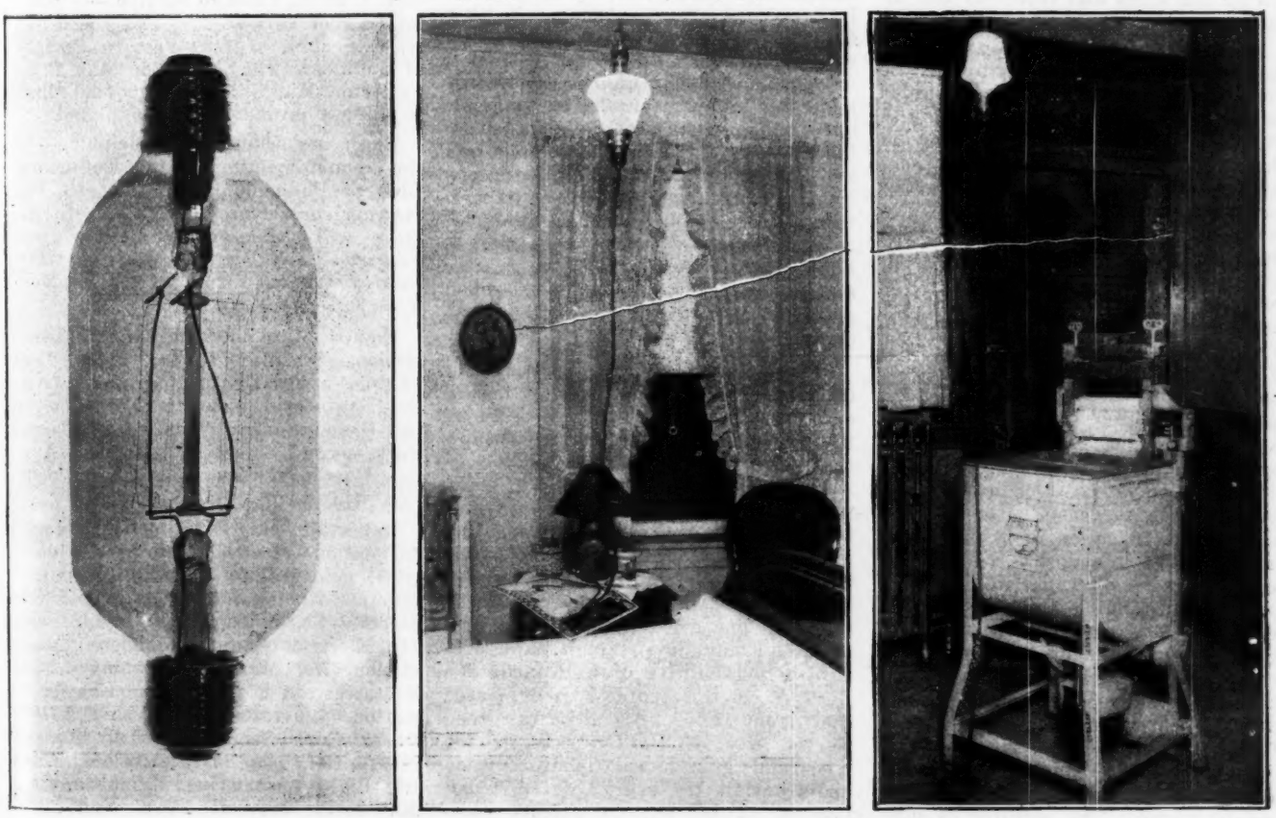
Four group sessions will be held simultaneously Wednesday evening, Thursday afternoon and evening and Friday afternoon, each with a topic assigned, as follows: (1) "Education for Foreign Trade;" (2) "Financing Foreign Trade;" (3) "Transportation and Communication;" (4) "Foreign Trade Advertising;" (5) "Direct Selling Abroad;" (6) "Banking Service to Foreign Trade;" (7) "Sources of Imports;" (8) "American Trade with China;" (9) "Foreign Trade and the Press;" (10) "Foreign Credits and Credit Information;" (11) "American Trade with Russia;" (12) "Foreign Trade Information;" (13) "Practical Problems of the Export Manager;" (14) "Webb Law in Operation;" (15) "Pacific Problems;" (16) "Foreign Delegates."

Double-Base Lamp for Simultaneous Use of Appliance and Fixture

A NEW double-base lamp by means of which household appliances and fixtures may be used simultaneously from the same outlet without the use of double plugs or adapters has been developed by E. O. Schweitzer, chief testing engineer of the Commonwealth Edison Company. The lamp may be made up in any style and capacity. The one shown in the illustration is the 60-watt "Mazda B" 115-volt filament mounting used with the standard S-21 bulb.

The lead-in wires are those used for the standard 500-watt, 115-volt type C lamp and continue through the bulb from base to base, the lamp filament being tapped off from them. The lead-in wires, which are formed into an expansion loop to eliminate strain due to unequal contraction and expansion of the lamp elements, are made with a quarter twist to provide clearance for the filament anchors. Exhaustion is carried out through a concealed tube within one of the bases, thus making a tipless lamp. By the addition of a light brass shell beaded at each end any standard shade holder may be used. With this connector any standard attachment plug can be used in the free end.

By using the double-base lamp a pendent fixture can be converted into a semi-indirect fixture. With such a fixture, it is claimed, any household appliance can be used without interfering with its lighting use.



THE DOUBLE BASE LAMP AND ITS DOUBLE DUTY

Current News and Notes

Timely items on electrical happenings throughout the world, together with brief notes of general interest.

A New Use for the Chinese Wall.—The United States Navy has erected for its own use upon the ancient wall of China a reinforced-concrete wireless mast, 164 ft. in height.

Ames (Iowa) Municipal Plant Losing Money.—At a recent meeting of the Ames (Iowa) City Council the city engineer reported that the municipal electric light plant was piling up a deficit of $1,000 to $1,200 a month owing to increasing costs and that some of the machinery is wearing out. A proposition to increase the rates was made, but the Council adjourned without adopting it.

Spiders Interfere with Telephones.—From Buenos Aires comes a tale of havoc raised by the ground spider with cable communication. "The spider," says the **Telephone Review**, "is simply working out his destiny. He spins a heavy web which is caught by the wind and wound around the wires. In a humid spell these masses of web become damp and short circuits result. So serious has the problem become that large forces of men are employed following the wires and removing the accumulations."

A Big Niagara Installation.—One of the largest contracts for hydro-electric equipment ever placed has been awarded to the William Cramp & Son Ship & Engine Building Company of Philadelphia by the Hydro-Electric Power Commission of Ontario, Canada. It calls for three turbines rated at 55,000 hp. each, to be installed at Niagara Falls on the commission's hydro-electric system. Five Johnson valves and five governors are included in the equipment, and delivery is to be made in from a year to eighteen months. Each of these units is larger than the original 50,000-hp. installation of the Niagara Falls Power Company.

Obviating Line Trouble in Chile.—Service on the system of the Chile Exploration Company, which has a great steam station at Tocopilla, on the seacoast, with 80 miles of transmission lines running inland, has been interrupted only once because of line trouble, notwithstanding that a salt mist from the sea is carried inland for about 10 miles and falls on the insulators, where it evaporates, leaving a deposit which would eventually cause flashovers. To overcome this condition, the 10 miles of line nearest the coast was built in duplicate, and the insulators on one line are washed while the other line is in use. The washing is done every other week.

Electrical Patents in Japan.—Nine hundred and twenty-eight electrical patents were applied for in Japan during the year ended October, 1919, an increase of 20 per cent over the preceding year. Seventy-six per cent of the applications were made by natives of Japan.

Daylight Saving in New England.—Daylight saving went into effect throughout Massachusetts on April 25 as a result of a recent statute. In northern New England much opposition continues to the plan, but in southern New England a disposition to cooperate is more apparent in local communities. Cities and towns in Rhode Island representing 70 per cent of the state population have adopted the plan and local communities in Connecticut have also made the change.

Hydro-Electricity in the Aluminum Industry.—It is announced that the Aluminum Company of America, which operates a plant at Alcoa, Tenn., covering 18,000 acres exclusive of timber tracts and water-power sites, is about to construct four more dams in the Little River for hydro-electric purposes. A dam already completed after two years' work is said to be the largest in the United States with the exception of the Niagara Falls and Roosevelt dams, and more hydro-electric power is already generated at Alcoa than in Tennessee's larger cities combined.

Electrolytic Refining of Iron.—Konrad Werner Lindman, a Swedish engineer, announces that he has been successful in refining iron by an electrolytic process, after experiments lasting for six months at the Avosta iron works. Hitherto electrolytically treated iron has contained a high percentage of hydrogen and uneven floccose masses, but Lindman makes the claim that by his method, of which the details are kept secret, an even and homogeneous iron plate, chemically free from impurities, can be produced at a minimum cost in sheets down to the thinnest dimensions, which possess a greater magnetic capacity than the usual rolled plate and do not require any after treatment.

Water Power of Nova Scotia.—An official commission has been gathering data on the water-power resources of the Province of Nova Scotia. Though these are not large individually, collectively they can be made of great value, the topography of the province favoring their development, as does the unusually heavy rainfall. The plan is to combine the water powers in isolated groups which can eventually be joined in one great system. The first of these groups is to exploit the hydro-electric possibilities of St. Margaret's Bay. From this source it is estimated that about 10,000 hp. can be furnished to the city of Halifax. While the provincial government is to develop and transmit the energy, its distribution is to be left to private companies.

Associations and Societies

A complete Directory of Electrical Associations is printed in the first issue of each month.

Association of Municipal Electrical Utilities of Ontario.—The semi-annual convention of this association is to be held at Niagara Falls, Ont., on June 17 and 18.

I. E. S., Philadelphia Section.—"Color Photography" will be discussed before this section of the Illuminating Engineering Society on May 21 by Henry Hess.

British I. E. E. to Have New President.—The council of the Institution of Electrical Engineers, Great Britain, has selected Llewelyn B. Atkinson as president for the coming term, in succession to Roger T. Smith.

A. I. E. E., Philadelphia Section.—As previously announced, Monday, May 10, is to be "students' night" for this section and devoted to a discussion on "Professional and Financial Aspects of Electrical Engineering."

American Society of Heating and Ventilating Engineers.—"The Design of Large Boiler Plants" is the subject of an illustrated paper to be read before this society at Philadelphia on May 13 by J. Grady Rollow.

A. I. E. E., Chicago Section.—A joint meeting of this section and the Electrical Section of the Western Society of Engineers will be held on May 12 in Fullerton Hall, Chicago, at 7:30 p.m., to discuss problems of city planning.

Engineers' Club of Philadelphia.—At the annual meeting of the Engineers' Club of Philadelphia, on May 18, the retiring president, Joseph A. Steinmetz, will speak on "Our Club," and Edward S. Walsh will describe "The Improved Barge Canal System of New York."

Empire State Gas and Electric Association.—On May 1 the headquarters of this association were moved from the Engineering Societies Building to the Grand Central Terminal Building, Forty-second Street and Madison Avenue, New York City, where the association will occupy Room 3052.

Important May Meetings.—Dates of conventions of special interest to electrical men still to be held this month follow: American Association of Engineers, St. Louis, Mo., May 10 and 11; Electrical Supply Jobbers' Association, Del Monte, Cal., May 12-14; Southwestern Electrical and Gas Association, Galveston, Tex., May 13-15; Pacific Coast Section, N. E. L. A., Del Monte, Cal., May 17-18; National Electric Light Association, Pasadena, Cal., May 18-21; Tri-State Water and Light Association, Atlanta, Ga., May 19-21.

Recent Court Decisions

Findings of higher courts in legal cases involving electric light, power and other public utility companies.

Threat of Discharge in Relation to Injury.—Where an employee doing work in a safe way is ordered to do it in an unsafe way with a threat of discharge if he refuses, and by reason of the order he enters upon the work and is injured without fault of his, the Supreme Court of North Carolina has held that he can recover damages. (102 S.E. 397.)

Both Negligence and Injury Therefrom Must Be Proved in Action for Damages from Flooding.—In a suit brought by a landowner against the Pacific Electric Railway Company to recover damages because of the flooding of his property, which he asserted to have arisen from the defective construction of a bridge by the defendant company, the reviewing court has held that in such cases the burden is upon the plaintiff to show by preponderance of evidence not only that the defendant was negligent but that such negligence was the proximate or concurring proximate cause of the injury. (187 P. 976.)

Compensation for Easement in Land Must Be the Same as for Use.—Holding that the right to use condemned land is just as much a taking of the land as if it were actually used all the time, the Supreme Court of South Carolina has held that where lands are condemned for a water-power project the landowner is entitled to compensation for all lands taken, even though as to some of them the condemnor desired only an easement. The owner is entitled to recover full compensation for all the land within the condemned area and the water-power company must pay the actual value of the total acreage over which it acquires the right to impound water. (102 S.E. 331.)

Powers of Public Service Commission and of State Supreme Court.—The Missouri Public Service Commission having refused to assume power to grant to a street-railway company permission to discontinue spur lines included in its franchise but asserted to be unprofitable and the railway's complaint having been carried to the Supreme Court of the state, that body held that the court had no authority to review the facts and make a finding of its own so long as the commission refused to do so. It further found that the commission was in error in holding itself constitutionally prohibited from taking such action, and the inferior court was ordered to vacate its judgment sustaining the commission and to remand the cause to that body for determination. (219 S.W. 380.)

Prejudiced Jurors in Damage Suits Against Utilities.—The Missouri Supreme Court, in Vessels vs. Kansas City Light & Power Company, held that the lower court was within its discretion in rejecting for jury duty a coal dealer who had done a large business with a closely allied utility, who refused to state whether jury duty would embarrass him in his business dealings and who expressed himself as prejudiced against personal injury actions. (249 S.W. 80.)

Public Service Commission's Power to Change Contract Rates.—A public utility is entitled to a rate sufficient to give it a fair return upon the reasonable value of its property at the time it is being used for the public, according to the decision of the Colorado Supreme Court in a suit brought against the Public Utilities Commission of that State by the Ohio & Colorado Smelting & Refining Company, and the Public Utilities Commission had power, for the public weal, to raise the rate fixed by contract between the Colorado Power Company and the smelting company before the creation of the commission. (187 P. 1082.)

Responsibility for Accident Caused by Reversal of Connections.—In Magnuson vs. City of Bainbridge, an electrician claimed damages from the city, which owns the power lines, because of injuries sustained by him while installing an elevator. Changes were made in the transformer connections while he was so employed and he was not informed that the connections had been reversed, with the result that when he was on top of the car and turned the switch with the intention of descending the car mounted instead, crushing him against a beam. The Court of Appeals of Georgia held that there was no cause of action against the city, it being the duty of the plaintiff to find out for himself what effect the alterations to the transformer, of which he was aware, would have. (102 S.E. 459.)

The Los Angeles Infringement Suit.—In its decision upholding a decree of the United States District Court which enjoined the execution of a local ordinance providing for a municipal street-lighting system that was held to trespass upon the privately owned lighting system of the defendant Los Angeles Gas & Electric Corporation, the Supreme Court of the United States said: "It will be observed that we are not concerned with the duty of the corporation operating a public utility to yield uncompensated obedience to a police measure adopted for the protection of the public, but with a proposed uncompensated taking or disturbance of what belongs to one lighting system in order to make way for another. And this the Fourteenth Amendment forbids. What the grant was at its inception it remained, and was not subject to be displaced by some other system, even that of the city, without compensation to the corporation for the rights appropriated."

Commission Rulings

Important decisions of various state bodies involving or affecting electric light and power utilities.

Burden of Proof of Need for Increased Rates Falls on Applicant.—The burden resting upon an applicant under the California public utilities act of showing that a proposed increase in rates is justified cannot, according to the Railroad Commission of that State, be satisfied by a mere perfunctory showing, but requires the applicant to show by evidence of probative value that the existing rates are unreasonably low and that the proposed rates are reasonable.

Steam-Heating Losses Should Not Be Recouped Through Electrical Department.—The rates charged by the steam-heating department of a public utility should render such department self-sustaining, the Illinois Public Utilities Commission has declared as the result of an examination of a new rate schedule submitted by the Decatur Railway & Light Company, and it would be contrary to the ruling of the Supreme Court of the United States to fix rates that fell below this standard on the theory that they are being recouped by the company from its rates for electrical service

City Buying Energy from Company Is in Same Position as Other Customers.—The city of Idaho Falls, Idaho, appealed to the Public Utilities Commission of that State against an order of the commission authorizing the Utah Power & Light Company to apply the emergency service rates scheduled by it to the city. The municipal authorities based their opposition to this order on a contract entered into before the establishment of the commission, but the latter body held that the city stood in no relation with the company different from that of any other patron and that the commission's right to issue the order could not be attacked.

Establishing Equitable Rates.—In proceedings to determine the reasonableness of rates adopted by the Southern Illinois Light & Power Company in several small towns the Illinois Public Utilities Commission has announced that increases in rates affecting a particular consumer are not inconsistent with smaller increases applied to other consumers where such a consumer was formerly served at rates much lower than those charged other consumers, the result of the increase being to eliminate discrimination. Rates for the towns concerned which were calculated to produce a return of 7.4 per cent on the original cost of the plant were authorized by the decision of the commission.

Men of the Industry

Changes in Personnel and Position—Biographical Notes

Benjamin F. Pearson, general superintendent of the southern division of the Southern California Edison Company, has recently been appointed power administrator of that company and will have complete authority over all the generating plants and power distribution of both divisions. This will involve control of the generation and transmission of nearly 1,000,000,000 kw.-hr. a year, with a peak load of approximately 190,000 kw., generated by nineteen hydro-electric and seven steam plants. In addition he will have charge of the interchange of energy between the Southern California Edison Company and the Southern Sierras Power Company, San Diego Gas & Electric Company, Mount Whitney Power & Electric Company and San Joaquin Light & Power Company. In this work Mr. Pearson will be assisted by Fred B. Lewis, superintendent of the Los Angeles district. Mr. Pearson, known throughout southern California as "Uncle Ben," was born in

B. F. PEARSON

Middlesex County, England, Sept. 19, 1868. After only a few years of schooling he served an apprenticeship with the Grand Junction Canal Company, England, as engineer and fitter. Immediately afterward he came to the United States and in January, 1896, entered the employ of the Southern California company. In addition to his duties as general superintendent and power administrator, Mr. Pearson is chairman of the engineering committee of his company, which has the engineering responsibility of the organization. He is also president of the Los Angeles City Civil Service Commission and is prominently identified with many public and philanthropic movements in southern California.

Bryant White has recently been appointed superintendent of the light and power departments of the Roanoke (Va.) Railway & Electric Company and the Lynchburg (Va.) Traction & Light Company, to succeed W. G. Claytor, who has been advanced to the position of assistant to the general manager of these companies. Mr. White was formerly electrical engineer with the Fred T. Ley Company on the construction of several large munition plants for the government. Prior to the war he was power engineer with the Public Service Company of New Jersey, and previous to that he held the position of sales manager of the Merchants' Heat & Light Company of Indianapolis.

W. J. Canada, who for the past year has been a member of the headquarters staff of Stone & Webster, Boston, associated with W. H. Blood, Jr., in preparing special reports, has been employed by the National Electric Light Association as head of its new engineering department at New York headquarters. Mr. Canada will take up his new duties on June 1 and pay particular attention to questions of inductive interference, insurance, the safety code and work with special technical committees of the association. Mr. Canada was graduated from the Sheffield Scientific School at Yale. After graduation he was employed in the testing department of the General Electric Company and then for two years as electrical engineer and assistant to the manager of the Ohio Electric Railway Company. He resigned that position to become electrical engineer in charge of the Dayton district for the Ohio Inspection Bureau. Later he took up safety work as electrical engineer of the Rocky Mountain Fire Underwriters' Association. In 1913 he resigned that position to become associate physicist for the Bureau of Standards, Department of Commerce, where he made a special study of electrical life hazard. Late in 1917 he resigned his position with the Bureau of Standards to enter work with the American International Shipbuilding Corporation of Philadelphia. That position he held until last fall, when he joined the Stone & Webster organization.

Lafayette Hanchett, who was recently elected president of the Utah Power & Light Company to succeed D. C. Jackling, who has resigned, is president of the Intermountain Electric Company of Salt Lake City, a progressive electrical jobbing house in the intermountain district. He also holds the same position with the Dixie Power Company, which operates in southern Utah in and around the town of St. George. Mr. Hanchett is in addition a director in the National Copper Bank and Bankers' Trust Company of Salt Lake City and is identified with several other large commercial enterprises. During the war he was closely associated with Mr. Jackling, acting as his assistant in charge of the government powder plant at Nitro, W. Va.

H. G. Harvey has resigned as commercial engineer of the Nassau Light & Power Company of Mineola, N. Y., to accept a similar position with the Pennsylvania Utilities Company at Easton, Pa.

Samuel G. Rhodes, who has been a member of the engineering staff of the New York Edison Company since 1891, was appointed assistant to Vice-president Lieb on April 1. Mr. Rhodes' first position with the company was that of wireman. In 1895 he was made fireman of the arc-light department and in 1906 superintendent of that department and engineer of the meter and test departments. Mr. Rhodes has served for a number of years on various technical committees of the National Electric Light Association, of the American Institute of Electrical Engineers and the

S. G. RHODES

Illuminating Engineering Society. He has conducted a considerable amount of original work for the New York Edison Company in illumination, particularly in connection with street and park lighting. He is a fellow of the A. I. E. E.

Arden B. Holcomb, whose appointment as general industrial engineer for Crippen & Funk, Youngstown, Ohio, was noted in the "Men of the Industry" for April 3, was then erroneously referred to as having been previously connected with two St. Louis electrical companies. The item should have said instead that Mr. Holcomb was formerly of the general engineering department of the Westinghouse Electric & Manufacturing Company at East Pittsburgh and before that held the post of electrical superintendent for the Standard Tinplate Company of Canonsburg, Pa. Before entering industrial work Mr. Holcomb spent seven years as an instructor in electrical engineering at Cornell University, Ithaca, N. Y., and the Carnegie Institute of Technology, Pittsburgh.

Trade and Market Conditions

News of the Trade for the Manufacturer, Wholesaler and Jobber of Electrical Equipment and Supplies—Notes on Industrial Activities and Business Methods

Electrical Materials Being Booked at New High Record

FROM the looks of things, manufacturers of electrical apparatus and supplies are moving on to new high records for the year 1920. Bookings for the first four months are at an unprecedented rate and are well in excess of the amount that manufacturing capacity can turn out. Several manufacturers have admitted this to be the case. Cancellations here and there would be quite welcome because then producers would feel that they could come nearer to filling their schedules. The one great drawback, besides that of the inability to get sufficient labor to man the machines and handle raw materials, in the manufacturing problem today is the shortage of rolling stock and poor transportation conditions, which are holding up the movement of both raw and finished materials. This condition is backing up shipping schedules in the plants and making it increasingly more difficult to close up the gap between booking and billing.

Noticeable increases in orders taken are found in generating apparatus and supplies. Orders on General Electric during the first quarter of 1920 were at the rate of $375,000,000 for the year, and during the month of April even this rate was increased. This brings bookings at a rate of $1,250,000 a day. Orders on Westinghouse during this first three months were at a rate of $180,000,000 for the calendar year, which is $600,000 a day. Shipping dates on a large part of the big apparatus and on certain small material, such as fractional-horsepower motors, will not be consummated during the present year, so that heavy billings are expected to carry over into 1921.

British Court Rules Against Gas-Filled Lamp Patents

WHAT appears to be a difference of opinion in the courts of England and the United States is found in a recent decision of an English justice handed down in the case of the suit brought by the British Thomson-Houston Company, Ltd., against the Corona Lamp Works, Ltd., for an injunction to restrain an alleged infringement of its patent, granted in 1913, for improvements in incandescent electric lamps.

The keynote of the patent was struck on the first pages of the specification, which described it as "relating to a gas-filled lamp of higher efficiency than the best lamp on the market." The defences were reduced to three, namely, want of invention or subject matter, insufficiency and non-infringement.

The court was of the opinion that the evidence clearly established the fact of infringement; on the question of "subject matter" or invention the court held that the patentee had taken "an inventive step of a high order of merit as well as of the greatest practical utility."

Thus far the opinion of the British court substantially agrees with the opinion handed down last fall by Judge Mayer in a suit brought by the General Electric Company against the Nitro Tungsten Lamp Company of Providence. The result of the two suits was, however, very different. It will be remembered that the American court sustained the patent. The English court holds the patent bad.

It seems that the claims of both the English and American patent call for a filament which is actually or effectively of relatively large size. The American court considers this a good limitation and a sufficiently definite one under the circumstances, whereas the British court holds that under the British law the expression "large" is indefinite and that because of the indefiniteness that is thus imported into the claims the patent cannot be sustained.

The ELECTRICAL WORLD is informed that the Nitro Tungsten Lamp Company has appealed from Judge Mayer's decision and that this appeal has been argued before the Circuit Court of Appeals of the Second Circuit. It is also understood that the British Thomson-Houston Company has appealed from the British decision and that it is expected this appeal will be argued at an early date.

Electric Sheet Mills Expected to Open Books in May

PRODUCERS of electric sheets have not in general opened their books for third-quarter or second-half year buying. The one producer who did open his books about the middle of April is reported to have based his prices on those suggested in the Industrial Board schedule. Prospective output is being allotted to the company's regular customers. It is expected that the other electrical sheet producers will open for the next quarter and half year some time between the tenth of May and the end of the month. As far as can be learned it is thought that the prices will be no higher than those ruling for the present term. The attitude is that prices are sufficiently high as they are and that a feeling of relief would follow a halt in the upward movement of steel products. The mills can do no more than to apportion out their sheets as they did previously.

There is very little more capacity available now than formerly, although one mill expects a bigger output about September. No bigger volume of ordering is expected. The demand is about that which existed over the earlier part of the year, and that demand was not satisfied, so a greater demand certainly cannot be filled. What new customers in the field will do for sheets it is hard to predict. Probably a good part of their demand can be satisfied through the jobbing interests at a rate higher than that of the producers. The regular customers will be pretty well cared for, however. Recent shipments have been badly held up by the railroad strikes. Some mills will not be able to clean up on their second-quarter deliveries until along in August because of curtailed production, shortage of raw materials and stoppage in freight movement.

Local Pole-Line Equipment Stocks Almost Gone

SUPPLIES of virtually all pole-line equipment are short in the market. It has been almost impossible to secure delivery on poles, cross-arms and wood pins for some time, and jobbers' stocks in the East and in the Middle West are swept clean. In the South conditions are better. Inquiries and orders in the Mid-West are off a bit, possibly because buyers feel it useless to place orders with deliveries as uncertain as they are. Cross-arms are reported in plentiful supply at the mills, but they cannot be moved to jobbers' yards. In some cases producers have been compelled to curtail operations because of congested shipping docks. Several carloads of arms are en route to Eastern markets but are held up by embargoes.

Wood poles, too, are short, especially in the 30-ft. and 35-ft. lengths. The 40-ft. and 45-ft. poles are in slightly

better supply. Red cedar is reported particularly hard to get and is said to be sold up for the year. Lack of snow in certain parts of the Northwest was responsible for fewer poles getting out of the woods last winter because of difficult sledding conditions.

Wood pins are so short in some East and Mid-West markets that Western Union steel pins are being substituted in places. Chicago and New York stocks are virtually exhausted, but several cars are in transit. In New York territory wood-pin prices are very uncertain, while in the Chicago market a recent advance has set lots of 2,000 to 3,000 at $52.94 per 1,000.

Line hardware is in better condition and stocks are in fair shape. Buying is good, in fact better than expected by some jobbers. Porcelain insulators are extremely short for nearby delivery under a good demand in small amounts.

Storage Batteries Sold on Deferred-Payment Plan

RATHER a new departure in the method of payment for storage batteries has been inaugurated by the Edison Storage Battery Company. Edison batteries for all services can now be bought on the deferred-payment plan, which divides payments over a period of twenty months. It is understood that a trade acceptance is taken with the original payment when the sale is made.

Metal Market Situation

ANOTHER week has gone by and there has been virtually no change in the copper market. Prices in the producers' market during the past month have increased one-quarter cent and have held almost the entire month at 19.25 cents. That price still holds for May and second-quarter delivery. Third quarter is marked at 19.50 cents. In the outside market, on the other hand, 18.50 cents is being asked for nearby deliveries, which is three-quarters of a cent below prices asked a month ago. This market is even a little less strong, as a rather large sale was reported this week at 18.37½ cents New York.

Demand in both markets is light. A few sales for near delivery are going through, but sales for futures are quiet. Unrest in four brass mills in New York State and in New England is helping to put a damper on buying for futures as the course of labor is so uncertain. Traffic, too, is still hindering deliveries to refineries, and renewed walkouts in Buffalo railroad yards add uncertainty to the future.

Lead stocks in the East are low. Labor shortage and poor transportation are serious adverse conditions which make production of the metal unsatisfactory. Nearby demand is better at from 8.75 to 9 cents in the outside market in New York. The leading producer's price is still 9.25 cents. Zinc shows little change over last week. At the bid price of 8.30 cents New York exporters were not very anxious to sell futures. There are sufficient stocks available for the small volume of sales going through.

NEW YORK METAL MARKET PRICES

	April 28	May 5
Copper	£ s d	£ s d
London, standard spot	103 10 0	101 5 0
	Cents per Pound	Cents per Pound
Prime Lake	19.00	19.00
Electrolytic	19.25	19.25
Casting	18.37½	18.37½
Wire base	23.00	23.00
Lead, trust price	9.25	9.25
Antimony	10.25	10.00
Nickel, ingot	43.00	43.00
Sheet zinc, f.o.b. smelter	12.50	12.50
Zinc, spot	8.20	8.20
Tin	61.50	58.00
Aluminum, 98 to 99 per cent	33.00	33.00

OLD METALS

	Cents per Pound	Cents per Pound
Heavy copper and wire	16.50 to 16.75	16.50 to 16.75
Brass, heavy	10.25 to 10.50	10.25 to 10.50
Brass, light	9.00 to 9.50	9.00 to 9.50
Lead, heavy	7.25 to 7.50	7.25 to 7.50
Zinc, old scrap	5.00 to 5.25	5.00 to 5.25

THE WEEK
IN TRADE

TRANSPORTATION conditions continue to improve. The Central West and the East are commencing to benefit, and much freight is now being received in the unscrambling process. The South and West, however, so far have failed to note any relief.

Heavy demand for conduit, armored conductor, wire and porcelain for suburban building in all sections is reported, with a question as to whether shipments will continue to arrive in sufficient quantity to keep the building program going. So far immediate needs are being met.

From the present rate of ordering, electrical manufacturers will break records this year.

Demand for generating apparatus, synchronous motors and general supplies is very large. Manufacturers are adding capacity, and it is expected that much better deliveries will be quoted in the near future on certain lines.

An increasing number of manufacturers are now billing prices effective date of shipment, with the result that jobbers have been inconvenienced to a considerable extent.

Jobbers are anxious about getting delayed freight shipments within the next few weeks as a considerable amount of the goods en route already have been sold.

NEW YORK

Volume of sales, which have been holding steady for several weeks past at a rate slightly below normal on account of lack of electrical goods, is increasing gradually. Business is reported good by most jobbers. Arrival of conduit, armored cable, wire and porcelain fittings has made it possible for some jobbers to transact more business than heretofore. Demand has been heavy for these roughing materials right along, but in most instances jobbers' stocks have been bare of these materials or so low that orders could not be filled. Lack of building materials, non-electrical, is now holding up some construction work. This condition, however, is temporary. Price changes have been made on switch boxes, armored conductor fittings and on annunciator wire.

Conduit.—Immediate needs are being met. One jobber received two carloads of pipe in different sizes, and others report consignments of 10,000 ft. up to half a car. A considerable amount delayed in shipment probably will be released within the next two weeks.

Flexible Armored Conductor.—Several jobbers have received amounts from a quarter of a car up to a carload. Demand is heavy and jobbers are distributing present supplies over wide limits.

Annunciator Wire.—Prices have been advanced approximately 5 per cent by at least one manufacturer. Shipments are poor and stocks are broken.

Switch Boxes.—One switch box has been advanced 3 cents, making the new price 24 cents. Stocks are low, but shipments en route are expected to help out considerably.

Heating Devices.—Of the Simplex heating devices which will advance on May 10, the 6-lb. flatiron goes to $8, the 8-in. disk stove and tailors' irons will increase $1, No. 27 range $10, and repair parts will be advanced between 10 and 25 per cent.

Schedule Material.—Demand greatly exceeds supply, which is low. Trucks continue to bring in supplies from Connecticut, but larger quantities are needed.

Non-Metallic Flexible Conduit.—Stocks are low, although as much as a car has been received during the week. Shipments by jobbers to contractors are being made by parcels post, 50 ft. to 60 ft. being shipped in each package.

Lamps.—Some stocks have been received by truck, but not nearly enough of the larger sizes. Heavy demand continues for the 75 and 100-watt sizes.

Sockets.—Stocks are dwindling rapidly, especially in the outlying districts. Some sockets have been received by truck with other schedule material, but so far not in large quantities.

Crossarms.—Jobbers' stocks are almost gone, but several carloads are en route from mills where stocks are fair.

Wood Pins.—Local stocks are out and in instances Western Union steel pins are being substituted.

CHICAGO

Continued difficulties in the movement of freight and a marked let-up in the volume of business in other lines have had but small effect on trade in electrical goods. The actual placing of orders seems to be at a somewhat slower rate than a few weeks ago, but inquiries are as heavy as ever. Wholly uncertain deliveries naturally have tended to slow up orders, but it is felt that with shipments moving more freely new business will resume its recent pace.

Extremely high material and labor cost and the consequent reluctance of bankers to finance construction have served seriously to curtail building operations in this district. Building permits are averaging under $2,000,000 a week. At present values this represents about one-third of the volume of construction which had been expected. If this situation persists, manufacturers of schedule material will be able to replenish stocks.

The transportation situation is improving daily. As a labor disturbance the strike about seems to have ceased, with the roads working about as many men as they need. A portion of these men are, however, new and inexperienced, and it will take much time, possibly six or eight weeks, to get freight movements back to normal. There is now no embargo on shipments to or from Chicago, but carriers still refuse to bill shipments through Chicago to points involving a transfer in this switching district.

A recent accident resulting in the complete disablement of the Des Moines (Iowa) gas plant has caused a rush of emergency orders for all manner of heating appliances for that city. As a result, toasters, grills, chafing dishes, ranges and percolators are temporarily unobtainable here.

Lamp Cord.—Silk-covered and cotton-covered cord are not to be had at any price, all quotations having been withdrawn. Cotton-covered cord is in stock in limited quantities at slightly advanced prices. Current quotation on No. 18 twisted is $42 per 1,000 ft. in small lots, $35 in 1,000-ft. lots, $30 in 2,500-ft. lots and $28 in larger quantities.

Motors.—Most makers are refusing to make prices or delivery promises on any fractional-horsepower motors as orders now on file will absorb the entire 1920 output. Some manufacturers can handle business on three months' delivery. Deliveries on large motors are uncertain. New prices have been made on slip-ring induction motors, constant-speed, 25-hp., 60-cycle, two-phase or three-phase, 220-volt dial type now being quoted at $870 list.

Oil Switches.—Inquiries are numerous for oil switches of standard type for protection of induction motors with all stocks low and many sizes missing. Delivery on shipments from factory ranges from eight to twelve weeks. List on the 2,500-volt switch, rated up to 200 amp., is $64.

Outlet Boxes.—Demand is not particularly heavy, limited quantities being found in jobbers' stocks. Delivery on factory shipments is slow. Standard type, 4-in., are quoted at $17 per 100; 3-in. at $13.75 per 100, in lots of from 100 to 500.

Knobs, Tubes and Cleats.—Stocks are fairly well maintained on these items, most jobbers being able to give immediate delivery. No. 5½ split knobs are listed at $48 per 1,000, less 50 per cent in barrel lots. Tubes, size $\frac{5}{16}$ in. x 3 in., are $18 per 1,000 list, less 45 per cent in barrels.

Plug Fuses.—Normal demand and stocks in good shape mark satisfactory conditions on this item. Jobbers' price on standard size lots of 500 is $5.60 per 100.

Heating Appliances.—Few appliances from factory have been delivered so far this year, probably less than 10 per cent of the expectation on hollow ware having been realized. All factories are reported as shipping every possible piece of hollow ware and many ranges to Des Moines, which will further delay the replenishment of Chicago jobbers' stocks. Orders continue to flow in from dealers in large quantities.

Intercommunicating Telephones.—This business remains merely normal, the largest demand being for factory installations. The almost negligible amount of apartment construction has kept requirements below the amount anticipated. Manufacturers are able to give immediate delivery.

BOSTON

Jobbers report continued intense activity in nearly all quarters. Deliveries are improving and some freight shipments have been received after long delays. Motor-truck shipments are still being used vigorously. The drain upon stocks is so heavy that little accumulation is possible either at the factories or by jobbers. Prices are firm, and further advances in copper wire are expected in some circles. Collections hold up extremely well, April payments being very satisfactory. Rigid conduit, motors below 10-hp. rating and insulating material are scarce. New building operations are slowing down somewhat owing to material supply difficulties, although residential work is increasing.

Wire.—Stocks are fairly satisfactory, although shipments are not in sufficient volume to permit much building up of supplies. Bare copper wire and weatherproof are steady at 24 and 28 cents base, respectively. Rubber-covered No. 14 sells for $11 per 1,000 ft. in 25,000-ft. lots and $11.50 in smaller quantities. Some price cutting is reported.

Flexible Armored Conductor.—Immediate needs are being met. No. 14 single-strip is quoted at $112 per 1,000 ft.

Non-Metallic Flexible Conduit.—Prices range from $35 to $37 per 1,000 ft. on $\frac{7}{8}$-in., and from $39 to $40 on ½-in. loom, recent motor-truck shipments adding about $1 per 1,000 ft. to selling expense. Stocks are not very large.

Washers.—Deliveries are improving. Stocks were kept up only by strenuous effort during the recent strike. One jobber shipped several carloads of washers by express at a cost of $8 per machine. An increasing demand is noted.

Vacuum Cleaners.—Shipments from New England are moving well into this market. One distributer of an outside outfit, however, has been unable to get a cleaner from the railroads for three weeks, although 1,500 are on the way. The demand is active, and factory enlargements are cutting down the necessity for night work. New models are being eagerly snapped up. In lots of six a representative make, with attachments, sells for $36.65 and a competitor of well-established design for $47.

Motors.—A slight improvement in factory output is noted. The sale of motors to second-hand machinery dealers for stock is being greatly curtailed, and an effort is being made to refuse motor delivery for speculative buying. Small direct-current motors, around 2-hp. rating, are almost unobtainable. Some factories are now greatly handicapped by sheet-steel shortages, and the supply of copper is giving trouble on account of labor difficulties in the Naugatuck Valley. Prices are firm.

Rigid Conduit.—Supplies are unsatisfactory and deliveries poor in the extreme. Little chance of improvement can be seen at present. One jobber reports not a foot of pipe in his place, and others are unable to care for trade except on a piecemeal basis.

Sockets.—Conflicting reports are heard as to supply, but in general immediate requirements are being well handled. The brass situation is disturbing and insulating material shortages are reported. Prices are steady, pulls in case lots netting 50 cents, keys 28 cents and keyless 25 cents.

Knobs and Tubes.—A few "Nail-it" knobs strayed into the Boston market a day or so since, and were quoted around $31.50 per 1,000, barrel lot basis. Tubes are scarce, a nominal quotation being $10 per 1,000 in barrel lots.

ATLANTA

Fundamental business conditions in the territory have undergone no change during the past week, although a slowing up in activities is becoming quite noticeable because of freight and express embargoes from the East and Middle West. Jobbers report that they have received little or no material from either of these sections since the rail strike became general, and as a result all lines of material have become rather scant, with complete exhaustion of stocks in certain lines. The outlook is for continued activity, provided that jobbers can obtain material in sufficient quantities. One of the largest manufacturers has notified the trade that prices on all material, except motors, panelboards and one or two other items, are subject to quotation at date of shipment only.

Building activities throughout the section continue brisk. A number of the largest textile mills in the country are well under way and new construction is being announced daily. Building permits in the city of Atlanta for the month of April totaled $1,750,000.

Collections continue to show some improvement and might be said to be satisfactory.

Conduit.—The conduit situation has shown no improvement, there being no shipments of moment since April 15; there are no stocks worthy of mention in the popular sizes and shipments are quoted at six months.

Flexible Armored Conductor.—Prices have advanced 10 per cent. There are no stocks in the territory, and such shipments as are being received are being allotted purchasers in an effort to meet the more urgent demands.

Metallic Flexible Conduit.—A price advance of 10 per cent is announced. There are no stocks in the territory, and shipments are quoted at from four to six weeks, which, in the face of the brisk demand, is not expected to be maintained. Prices, ½-in., $104.40 per 1,000 ft.

Armored Lamp Cord.—Demand has slowed up in the past thirty days and good stocks have accumulated in the territory. It is a question whether this article will show renewed activity in the very near future. Price, $55 per 1,000 ft.

Exhaust Fans.—Moving-picture theaters are responsible for the unusual activity, and the anticipation of their demand enabled jobbers to accumulate good stocks, sufficient for the season. Price, 32-in. Ventura, $185.

Printing-Press Apparatus.—There is a heavy demand for push-button-control, single-phase apparatus for flat-bed press machines. Local stocks for this class of apparatus are badly depleted and shipments are reported unsatisfactory.

Panelboards.—Panelboards for all classes of lighting installation are moving briskly, although this line was somewhat dull up to two weeks ago. Industrial and commercial building activities account for this renewed activity. Shipments are from five to six weeks; cabinet boxes, two to three weeks.

High-Tension Transformers.—Stocks of high-tension transformers, 6,600 volts to 44,000 volts, both indoor and outdoor types, are completely exhausted. The demand, due to industrial plant electrification, is very brisk, and shipments are quoted at from fourteen to twenty weeks. Repair parts for this class of apparatus are reported equally hard to obtain.

SAN FRANCISCO

There is plenty of building, despite construction costs that would have been deemed prohibitive a few years ago but which now pass unquestioned because of the dire need for new buildings. The yardmen's strike has delayed westbound shipments so that stocks in many lines are running low. Some shipments have taken as long as forty-five days, about double the normal time. Local shipments are moving fairly well, although the railroad companies will not receive them except on certain stated days of the week.

Sewing Machines.—Sewing machines are now definitely established in electrical dealers' stores. The more expensive, such as the rotary machine, are now selling above the cheaper vibrating machines formerly the best sellers. Increased prices have apparently not hurt the market, for April is reported to be the best month of the year; the average vibrating machine now sells for $60 and the rotary machine for $80.

Motors.—Delivery conditions on motors, especially in the larger sizes, are better than they were, although freight shipments have prevented the accumulation of any stock. The pumping plant business is excellent, and now that the increased amount of reservoir storage permits power companies to handle the load a banner motor year may be looked for.

Farm Plants.—Agents report good sales. Devices for these plants are selling splendidly when they are to be had.

Lamps.—Coast deliveries are fair, owing to the Central Coast location of the Oakland lamp works. In fact, it appears that they are better than those which obtain in the East, where the construction and equipment of many new factories have piled up back orders. Very keen competition for renewal of dealers' contracts is reported with a lessened stabilization of regular renewals. There is keen competition among dealers for industrial contracts.

Fixtures.—Dealers report a good sale for fancy, stand and ceiling lights with parchment or silk shades. More attention is being paid to lighting problems, especially in the larger interior cities, such as Fresno, where the demand, with its new angles of call, has about swamped the local dealers.

Conduit.—Conduit is still scarce, such scattered shipments as recently reached the Coast being common property as long as they last.

SEATTLE—PORTLAND

Stocks along every line are exceedingly short and replacements are coming in so irregularly that attempts to build them up are futile. Sale volumes on all lines, with the possible exceptions of heavy power apparatus, continue to fall, orders being in excess of available supply. There is a brisk demand for domestic appliances, particularly washing machines, fractional-size motors, schedule materials and wiring devices.

Freight embargoes are responsible for the slow and irregular freight service and heavy demand. Collections in Seattle are good. Other cities in the district report collections from fair to good. Applications for new credits are comparatively few.

Building operations on a large scale are being considerably retarded owing to lack of electrical and other materials. However, in spite of this, residence construction is going ahead rapidly and numerous big business projects are being started. Portland territory reports that business in general continues better than last year. However, most of it is being done for future deliveries of from four to six months or more. Merchandise from the East is becoming more and more difficult to obtain on account of the railroad strike. The freight embargo locally, however, has been lifted and little difficulty seems to be experienced at the present time.

Price increases of approximately 10 per cent have been made on practically all motor accessories, including starting switches, and also on turbines.

Recently several lumber companies announced intentions of increasing motor equipment and are preparing to completely electrify their plants.

Lamp Fixtures.—Sales during April, in Seattle especially, far exceeded those of last year. This applies to both industrial and domestic types, although the movement in the latter was by far the heavier. Demand for domestic types has practically absorbed all available stocks. Prices are trending upward.

Vacuum Cleaners.—Trade is exceptionally brisk, with all lines sharing popularity. The majority of jobbers are encountering difficulty in maintaining a semblance of stocks. Prices have shown no recent advance.

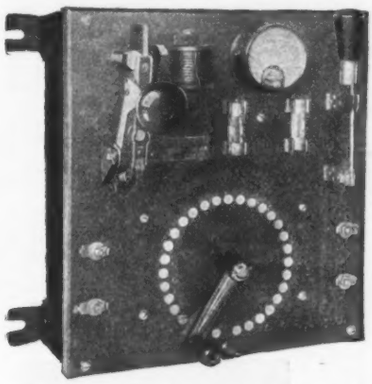
Meters.—Demand is steadily increasing particularly in Puget Sound District. Deliveries are coming through slowly and stocks are broken. Prices have shown no recent advance.

NEW APPARATUS & APPLIANCES

A Record of Latest Developments
and Improvements in Manufacturers' Products
Used in the Electrical Field

Rheostat for Charging Automobile Batteries

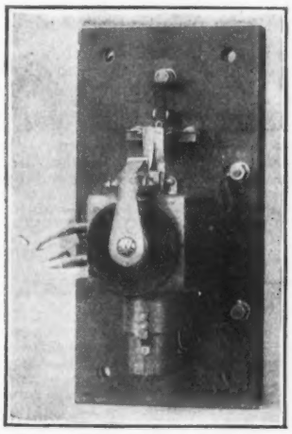
For charging storage batteries used for electric lighting, starting and ignition on gasoline cars, the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has developed equipment which is to be used with a direct-current source of supply. The charging set consists of a slate panel mounted on a wall-type frame and carrying a low-current cutout, single-pole main-line knife switch and fuses, ammeter, and thirty-step rheostat, and, says the manufacturer, is capable of charging from three to forty-two cells in series.



CHARGES UP TO FORTY-TWO CELLS

Circuit-Breaker Relay for Direct-Current Trip Circuits

The type KN relay now being manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., may be used either as a signal relay or a trip-free relay. As a signal relay it operates as audible or visible signal.



MAY BE USED AS SIGNAL OR AS TRIP-FREE RELAY

The signal relay is intended for direct current only, though it may be supplied for alternating-current operation. The standard-voltage coil may be used on control circuits of 100 volts to 250 volts. For voltages below this a special coil must be used, while for higher voltages a resistor must be inserted in series with the coil. The latch release coil is rated in accordance with the current required by standard trip coils, and relays can be supplied for ½, 1 and 3 amps. The signal relay has its main coil wound for voltage operation and its release coil wound for current operation. All coils are designed for momentary operation only and are so connected that they are in the circuit only for the time required by the operation of the apparatus.

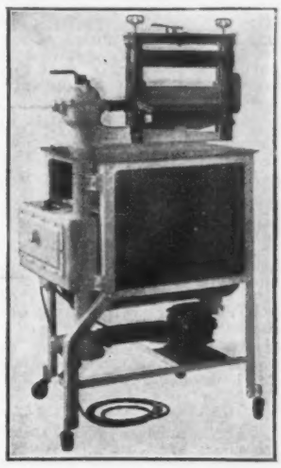
Day-Color Lamps for Store Use

A lamp which, by means of a colored glass filter, is designed to produce light resembling natural daylight has been developed by the Western Electric Company. The color is in the glass and is guaranteed not to fade or otherwise change. The lamp casing is of copper, the upright support is of drawn-brass tubing heavily copper-plated, the base is of cast brass or bronze, and the projecting ends of the deck plate—the actual foundation of the lamp—are of cast iron, finished in black lacquer. A 150-watt Mazda C lamp is used.

COLORED GLASS FILTER GIVES DAY-COLOR LIGHT

Washing Machine with Reverse-Cylinder Action

A washing machine that operates on the reversing-cylinder principle is being marketed, under the trade name "G. R. S.," by the General Railway Signal Company, Rochester, N. Y. The perforated maplewood cylinder makes one revolution and then reverses. The clothes are carried through the water and dropped forty-four times a minute. A swinging wringer with reversible drainboard may be locked in five positions. Other features of the machine are double-worm gear drive, a ¼-hp. splash-proof motor and all working parts are sealed in a life-long lubricant. The capacity is eight sheets and floor space occupied is 24½ in. x 28 in.



CYLINDER ACTION IS REVERSING

Inclosed Starting Switch

An inclosed motor-starting switch is about to be marketed by the Frank Adam Electric Company, St. Louis, Mo. The switch is of the safety type and circuit is not opened when changing from starting to running position.

Magazine-Type Dry Cell

The "Mono-Cell" is the 2¼-in. magazine-type dry cell developed by the Interstate Electric Novelty Company, Brooklyn, N. Y.

Notes on Recent Appliances

Ventilating Fan

The "Scouplex" ventilating fan has been placed on the market by the L. J. Wing Manufacturing Company, New York City.

Valve Grinder

The Eclipse Valve Grinder Company, Kansas City, Mo., has placed on the market a motor-operated, internal-combustion-engine valve grinder.

Safety Entrance Switch

A safety entrance switch to prevent theft of current has been developed by the Lewis Electric Company, Massillon, Ohio.

MANUFACTURERS' ACTIVITIES

Record of Changes Affecting Sales and Distribution Together with Trade Personals and Notes on Foreign Trade, Jobbers' News and New Trade Literature

THE HAAG BROTHERS COMPANY, Peoria, Ill., manufacturers of washing machines, is constructing a new factory which measures 150 ft. x 280 ft. The company is planning to double its output within the next four or five months.

THE RADIUM LUMINOUS MATERIAL CORPORATION, manufacturer of "Undark" luminous material for wall switches, etc., announces the removal of its New York City offices to 58 Pine Street.

THE BLACK & DECKER MANUFACTURING COMPANY, Towson Heights, Baltimore, Md., has opened its Northeastern branch office at 169 Massachusetts Avenue, Boston. A service station for its product will be maintained at the same address. D. G. Caywood, Northeastern district manager, will have headquarters at this office.

THE WAGNER ELECTRIC COMPANY, St. Louis, Mo., has announced the removal of its Pittsburgh office to 530-534 Fernando Street, to continue in charge of Ludwig Hommel.

THE H. S. B. W.-COCHRANE CORPORATION has been incorporated under the laws of the State of Pennsylvania to take over the entire business and holdings of the Harrison Safety Boiler Works, Philadelphia, Pa. The management of the business, including the engineering, manufacturing and selling organization so long identified with the Cochrane line of steam specialties, continues as before. The officers are: Joseph S. Lovering Wharton, president; John C. Jones, vice-president and general manager; William S. Hallowell, secretary and treasurer; Horace E. Sibson, general sales manager.

THE COMBUSTION ENGINEERING CORPORATION, 11 Broadway, New York City, announces the resignation of its vice-president in charge of sales, E. P. Moritz, owing to continued ill health. No successor to Mr. Moritz has been named by the company up to date.

THE PNEUVAC COMPANY, Worcester, Mass., has acquired a new manufacturing plant in Worcester. This plant has a floor space of 168,000 sq.ft. and will be devoted exclusively to the manufacture of the one type of "Sweeper-Vac" with motor-driven brush. The plant will enable the company to reach an output of 1,500 machines daily.

WESTINGHOUSE CHANGES.—E. A. Wooten has been appointed manager of the industrial division of the Detroit district office, Frank H. Nealis has been appointed manager of the supply division of the Cincinnati district office, and H. M. Wible has been appointed acting manager of the newly established rectifier section, supply department, of the Westinghouse Electric & Manufacturing Company.

THE LUX MANUFACTURING COMPANY, 123 East Kinney Street, Newark, N. J., manufacturer of tungsten and nitrogen lamps, contemplates an addition to its plant. The proposed building will provide about 40,000 square feet of manufacturing space.

THE SETHMAN ELECTRIC & MANUFACTURING COMPANY, Denver, Col., is having plans prepared for the erection of a plant at Forty-second Avenue and Josephine Street, to cost about $400,000. The chief product of the plant will be an electric generator designed by George H. Sethman, president of the company.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has announced that new discounts to the trade applying to lists of spare parts for Emerson oscillating, non-oscillating and ceiling fans and to lists of spare parts for Northwind fans will be found in discount sheet No. 8025, dated March 15, 1920, and effective on that date. Discounts on spare parts formerly appearing in motor price book have been withdrawn and new discounts are being quoted on motor parts on request.

THE WHITE LILY MANUFACTURING COMPANY, Davenport, Iowa, has started work on the erection of its new factory, which will provide about 50,000 sq.ft. additional space.

THE UNITED STATES ELECTRIC COMPANY, New London, Conn., recently organized, has leased a building near the experimental station which it will equip for the manufacture of machines for doing planing by electricity and for heating rivets by electricity.

THE SAFETY CAR HEATING & LIGHTING COMPANY, 206 Erie Street, Jersey City, N. J., has disposed of its local plant and is planning to remove its works to New Haven, Conn., in the fall.

THE A. B. SEE ELECTRIC ELEVATOR COMPANY, Pacific Avenue, Jersey City, N. J., contemplates an addition to its plant, to cost about $16,000.

THE AUTOMATIC ILLUMINATED ADVERTISING CORPORATION, 816 West North Avenue, Baltimore, Md., recently incorporated with a capital stock of $200,000, plans to manufacture outdoor electric displays and automatic machinery for advertising purposes.

THE A. C. ELECTRICAL MANUFACTURING COMPANY, Dayton, Ohio, is preparing plans for a steel and concrete plant, the first unit to contain about 100,000 sq.ft. of floor space. The capital stock of the company has been increased from $100,000 to $600,000, primarily for financing business on hand and contemplated.

THE McMULLEN MACHINERY COMPANY, Grand Rapids, Mich., has organized a handling and conveying department which will specialize on electric and pneumatic cranes and hoists, overhead systems, chain and belt conveyors and construction machinery.

THE SUNLIGHT CARBON COMPANY, Red Fork, Okla., plans to equip a plant for the manufacture of carbon and its products for use in electrical machinery.

THE UNIVERSAL MOTOR COMPANY, Oshkosh, Wis., manufacturer of self-contained electro-generating units for farms, etc., has purchased a site at Fifteenth and South Main Streets on which it will erect a new plant to supplant its present works on Ceape Street. The new works will increase the company's floor space from 12,000 to 90,000 sq.ft.

THE BRYANT ELECTRIC MANUFACTURING COMPANY, Bridgeport, Conn., is enlarging its factory to meet the demands of increasing business. A four-story-and-basement addition of 100,000 sq.ft. floor area will be built at once to hold finished goods and the present finished-goods storage quarters, 155 ft. x 60 ft. and three stories high, with basement, will be used for the storage of parts. The original Bryant factory on State St., 128 ft. x 40 ft., is to be faced with brick, widened to 60 ft. and run up to four stories, giving additional office space. A 36-car garage for company use has just been completed. The Company reports very active business, far exceeding that of last spring to date.

THE AJAX ELECTROTHERMIC CORPORATION was incorporated April 26 to take over from the Pyrolectric Instrument Company, Trenton, N. J., the manufacture and sale of the Ajax-Northrup high-frequency induction furnace. It also takes over from the Ajax Metal Company the Northrup patents. The Ajax Electrothermic Corporation has its offices and works in the old home of the Pyroelectric Instrument Company, 636 East State St., Trenton, N. J. The Pyrolectric Instrument Company continues in the pyrometer and instrument business in other quarters at the same address. Furnaces are now commercially available for operation on single-phase circuits to 20 kw., on two-phase circuits to 40 kw. and on three-phase circuits to 60 kw. Larger units are possible. G. A. Clamer is president of the new corporation, Edwin F. Northrup, formerly of the Leeds & Northrup Company, and at present professor of electrical engineering at Princeton University, is vice-president and technical adviser; H. F. Porter is treasurer, and Dudley Willcox is secretary and sales manager.

Supply Jobbers' Notes

Western Electric Sales Changes

J. L. RAY, manager at Pittsburgh, has been appointed power apparatus sales manager in the general sales department in New York. Mr. Ray started with the company in 1905 in the drafting department, and the next year found him in the power apparatus sales department in New York. In 1912 he was made assistant sales manager in Pittsburgh, and the next year he became sales manager at the same house, from which post he was in 1918 promoted to be manager.

W. H. MACCRELLISH has been appointed manager at Pittsburgh, succeeding J. L. Ray, who was transferred to New York. Mr. MacCrellish began his career with the company in 1905 as shop clerk in Philadelphia. In 1911 he was chief clerk in Boston, the next year he went to Buffalo as stores manager, and with the same title he went subsequently to Minneapolis and then to Boston. In 1916 he went to Buenos Aires as assistant manager.

M. A. BUEHLER, who has been sales manager at Omaha, Neb., since 1917, has been transferred to Minneapolis, Minn., as sales manager of that office.

E. LUM has been appointed sales manager at Omaha, Neb., succeeding M. A. Buehler, who was transferred to Minneapolis. Mr. Lum has been with the company since 1905 and since 1912 has been a salesman in Omaha, Neb.

THE PERRY-MANN ELECTRIC COMPANY, INC., Columbia, S. C., announces the appointment of Col. A. M. Jackson as sales manager, effective May 1. Colonel Jackson comes from the supply department of the Schenectady office of the General Electric Company, with which company he became associated in 1898. He was connected with armature-winding, switchboard assembly and machine-shop practice for three years, and then took up construction work on outside installations. In 1906 he entered the supply department and for four years was interested in engineering and sales of street and interior illumination, transferring to supply-house interests and retail connections of the company in 1910.

A. M. JACKSON

Foreign Trade Notes

CZECHO-SLOVAK TRADE JOURNAL IN ENGLISH.—Volume 1, number 1, of the *Czecho-Slovak Trade Journal*, dated April, 1920, has been published in Prague-Vinohrady, Czechoslovokia. The paper is characterized as the only commercial paper in that country published in English. To acquaint the commercial circles of English-speaking countries with the economical position of Czechoslovakia, 4,000 copies of this first number have been sent abroad.

THE CROWN ELECTRIC MANUFACTURING COMPANY, LTD., 17 Pearl Street, Brantford, Ont., Can., is erecting an addition to its plant, to cost $16,000.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered, further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number.

A merchant in Switzerland (No. 32,605) desires to purchase electric supplies and implements of all kinds for the wholesale trade, such as sockets, switches, pull switches, cutouts, flat steel wire clasps, small electric motors (1/10 hp. and 1/25 hp.) and resistance wire for heating apparatus.

A merchant in England (No. 32,608) desires to be placed in communication with the manufacturers of an electrical suction cleaner similar to the one which is being sold on the English market, with a view to purchasing.

An engineer in Belgium (No. 32,575) desires to secure the general agency on a commission basis for the sale of small electric apparatus, electric lamps, etc., used in connection with the mining industry.

A commercial agent in Spain (No. 32,610) desires to secure an agency for the sale of electrical material.

A commercial agent in New Zealand (No. 32,638) desires to purchase and also to secure an agency for electric cloth cutting machines.

Trade Publications

ELECTRIC COOKING APPLIANCES.—The Duparquet, Huot & Moneuse Company, New York, N. Y., has issued catalog No. 22, covering its heavy-duty electric cooking equipment for hotels, restaurants, clubs, steamships, etc.

LIGHTING SYSTEMS.—"Eye Comfort" is the title of a folder inclosing booklet and leaflets being distributed by the National X-Ray Reflector Company, Chicago, describing and illustrating its direct and indirect lighting systems and apparatus for same, including projectors, reflectors, mountings, etc.

INSULATING MATERIALS.—The Continental Fiber Company, Newark, Del., has published an eighty-eight-page booklet entitled "Insulation," in which it describes the various products manufactured by the company, including vulcanized fiber, "conite," "bakelite-dilecto," etc.

New Incorporations

THE RENEW ELECTRIC LAMP CORPORATION of New York, N. Y., has been chartered with a capital stock of $100,000 by C. M. Stuart, Jr., M. V. Ryan and J. R. Moynihan, 408 West 150th Street, New York City.

THE DORRA MANUFACTURING COMPANY of New York, N. Y., has been incorporated by L. E. Rogers, F. A. Stroh and B. P. Ryan, 320 West Eighteenth Street, New York City. The company is capitalized at $5,000 and proposes to manufacture heat and light saving appliances.

THE SUPERIOR ELECTRICAL FIXTURE & APPLIANCE COMPANY of New York, N. Y., has been incorporated with a capital stock of $10,000 by H. and A. and I. Fistel, 332 Bedford Avenue, Brooklyn, N. Y.

THE AMERICAN ELECTRICAL INSTRUMENT COMPANY has filed articles of incorporation under the laws of the State of Delaware with a capital stock of $500,000. The incorporators are William O'Keefe, George G. Steigler and E. E. Aberle of Wilmington, Del.

Construction News

Projects, Plans, Bids and Contracts, Contemplated or Under Way

New England States

AUGUSTA, ME.—The Central Maine Power Company has been granted permission by the Public Utilities Commission to purchase the plants and system of the Androscoggin Electric Company, the Knox Electric Company and the Oxford Electric Company.

BAR HARBOR, ME.—The Ellsworth & Bar Harbor Power Company has applied to the Public Utilities Commission for permission to extend its lines to Deer Isle and Stoningham.

WEST SPRINGFIELD, MASS.—Contract will soon be awarded by the Wico Electric Company for the construction of the first unit of a new plant to cost about $75,000. McClintock & Craig, 33 Lyman St., Springfield, Mass., are engineers and architects.

PROVIDENCE, R. I.—The Narragansett Electric Lighting Company is planning the erection of offices and modern service buildings for meter, arc lamp, underground cable and transformer departments, on a ten-acre tract of land near Melrose Park.

DANIELSON, CONN.—The Goodyear Tire & Rubber Company, East Market St., Akron, Ohio, has awarded contract to the Hunkin-Conkey Construction Company, Century Building, Cleveland, Ohio, for the construction of a manufacturing plant and power house, to cost about $3,500,000.

NEW BRITAIN, CONN.—The Public Utilities Commission has approved the application of the Connecticut Light & Power Company for the construction of an aerial cable for a 13,200-volt electric distributing system across lines of wires and rights of other corporations and along Myrtle St.

Middle Atlantic States

BROOKHAVEN, N. Y.—The Long Island Lighting Company, Northport, L. I., has applied to the Public Service Commission for permission to erect a transmission line in the town of Brookhaven.

HAMBURG, N. Y.—The Depew & Lancaster Light, Power & Conduit Company of Lancaster has been granted permission to erect an electric light plant in this city.

POTSDAM, N. Y.—St. Lawrence Transmission Company has applied to the Public Service Commission for permission to extend its lines to the town of Russell.

REDWOOD, N. Y.—The Northern New York Utilities, Inc., of Watertown is planning to build a substation in Redwood and erect a three-phase high-tension transmission line from Redwood to Alexandria Bay, a distance of about 8 miles. The cost is estimated at about $40,500. J. B. Taylor is president.

DOVER, N. J.—The Richardson & Boynton Company, manufacturer of boilers and furnaces, is planning the installation of new electrical equipment, including motors, compressors, etc., in its factory.

HACKETTSTOWN, N. J.—Plans have been completed by the Town Council for the rebuilding of the municipal electric fire-alarm system, on which work will begin at once.

HARRISON, N. J.—The New Jersey Tube Company plans to change its switchboard outfit and to install two 150-kw. three-phase transformers. Philip Arnheiter is manager.

EDWARDSVILLE, PA.—The Wilbur Robson Silk Company is in the market for seventy-five electric motors.

ERIE, PA.—Plans have been prepared by the Skinner Engine Company, Twelfth and Chestnut Sts., for the construction of a power house and shop building, and alterations to its existing factory, to cost about $80,000.

MILLVALE, PA.—Bids will be received by G. Walter Bauer, borough clerk, until May 11, for the installation of a street-lighting system.

PHILADELPHIA, PA.—An appropriation of $358,000 for the completion of the power house and the installation of an electric transmission system in the Frankford arsenal has been made.

PITTSBURGH, PA.—The East Pennsylvania Gas & Electric Company is reported to have bought a tract of thirty-six acres at Edgely, and plans to build a power plant. At present the company receives its energy from the Philadelphia Electric Company.

SHARPSBURG, PA. — The Borough Council of Aspinwall has applied for permission to incur an indebtedness of $50,000 for improvements and extensions to its electric light and water plant.

YORK, PA.—The York Railways Company is planning extensive improvements to its traction system, including installation of new equipment in its local power station, rebuilding trolley system between Symsers and Hanover and erecting new substations in Martins and Gitts Run, etc.

FREDERICK, MD.—The Hagerstown & Frederick Railway Company is planning the construction of a 33,000-volt transmission line to connect its plant in West Virginia with its local plant, to cost about $60,000.

WASHINGTON, D. C.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing at the various navy yards and naval stations supplies as follows: Until May 11, South Charleston, W. Va., Schedule, 6,043—six electric hoists; Yorktown, Va., Schedule 6,020—3,000 porcelain strain insulators; Schedule 6,023—3,000 copper-wire thimbles; Brooklyn, N. Y., Schedule 6021—switchboards and panels. Until May 14, Washington, D. C., Schedule 6,031—7,000 ft. rubber-insulated cable. Until May 18, Mare Island, Cal., Schedule 6,025—electrodes, plug and joint compound; Yorktown, Va., Schedule 6,060—18,000 electric cable connectors. Applications for proposals should designate schedule desired by number.

North Central States

BAY CITY, MICH.—Contract has been awarded to the Bay City Stone Company, 1,704 Woodside Ave., for the construction of a dry kiln and power house, to cost about $50,000, by the Bigelow-Cooper Company.

CINCINNATI, OHIO.—Bids will be received at the office of the United States Engineer, Cincinnati, until May 19, for furnishing and installing river wall power-plant machinery, river wall valve jacks and machinery and lock piping, etc., for Dams 33 and 39, Ohio River. Alternate bids will be received for furnishing and delivering above without installing.

CINCINNATI, OHIO.—Bids will be received by the clerk of the Board of Education, eighth floor, Denton Building, Seventh and Race Sts., Cincinnati, Ohio, until May 24, for furnishing materials and labor to complete the installation of electric lighting in the public school on Seventy-fourth St., Carthage, in the city of Cincinnati. Plans and specifications may be obtained at the office of C. W. Handman, business manager, 511 West Court St.

CLEVELAND, OHIO.—The Public Utilities Commission of Columbus has authorized the Cleveland Electric Illuminating Company to issue $1,150,000 bonds for improvements.

EARLINGTON, KY.—Arrangements are being made by the St. Bernard Mining Company to extend its electric light service to the towns of Hanson and Slaughters.

VINCENNES, IND.—The Board of Works has approved a five-year franchise with the Indiana Power Company to furnish street lighting for the city.

CHICAGO, ILL.—The Illinois Malleable Iron Company, 1,801 Divergey Boulevard, plans to erect a new central power plant to replace three separate plants. The generating equipment will include two direct-connected engine-driven units, one of 350 kw. and the other of 500 kw.

TAYLORVILLE, ILL.—Bonds to the amount of $80,000 have been voted for the construction of a municipal electric light plant.

SHEBOYGAN, WIS.—Contract has been awarded by the Badger State Tanning Company to Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York, N. Y., for the construction of a tannery, to cost about $750,000. Considerable electric equipment will be required.

LETTS, IOWA.—Plans are being considered to connect the town with a high-tension transmission system. Improvements to the local street-lighting system are also under consideration.

KANSAS CITY, MO.—The South Main Street Improvement Club has appointed a committee to investigate and decide upon its lighting system, to be installed on Fiftieth Street between Armour Boulevard and Thirty-ninth Street. The extension of the lighting system to Wesport Avenue or Forty-third Streeet is also being considered.

DOLAND, S. D.—Bonds to the amount of $17,000 have been voted for improvements to the local electric light plant.

JOHNSON, NEB.—A bond issue will be submitted to the voters of the village of Johnson for the purpose of erecting a transmission line to Auburn or to the Graf terminus of the Tecumseh light system.

AMERICUS, KAN.—At an election to be held on May 14 the proposal to issue $18,000 in bonds to establish a lighting system in the town will be submitted to the voters. The present plans contemplate the erection of a transmission line to Emporia to obtain electricity for the proposed system.

DWIGHT, KAN.—The local electric light plant, owned by the R. B. Fegan Company, has been sold to H. P. Bader and W. S. Scott of this city.

Southern States

GREENSBORO, N. C.—The Southern Power Company of Charlotte, it is reported, will apply for a franchise to erect and operate an electric system in this locality.

TAMPA, FLA.—An issue of $280,000 in bonds for the erection of a new power plant, improvements to the waterworks system, etc., is under consideration.

KNOXVILLE, TENN.—The question of electrifying the filtration plant of the local waterworks is under consideration.

TAZEWELL, TENN.—The Claiborne County Light & Power Company, recently organized with a capital stock of $25,000, is planning to erect a transmission line to connect at Cumberland Gap with the transmission system of the Kentucky Utilities Company of Louisville, Ky. The plant and system of the Tazewell Light & Power Company will be taken over by the new company of which J. P. Ritchie of New Tazewell is president.

HEBER SPRINGS, ARK.—Contract will soon be awarded by the Arkansas Hydro-Electric Development Company for the erection of the first unit of the power plant and dam on the Red River, to cost about $320,000.

TECUMSEH, OKLA.—The State Board of Affairs has awarded contract to the Manhattan Construction Company, Oklahoma City, Okla., for the erection of an administration building, a school, two cottages and a power plant, to cost about $153,000.

ABILENE CITY, TEX.—Arrangements have been made whereby the American Public Service Company will take over and operate the Abilene street-railway system. Improvements, consisting of new equipment, repairs to power plant, track and transmission lines, will be made, costing more than $60,000. A. Hardgrave, Southwestern Building, Dallas, is state manager for the company.

Pacific and Mountain States

FRESNO, CAL.—The San Joaquin Light & Power Company has been granted permission by the State Water Commission to divert 3,200 acre ft. per annum for storage and 900 ft. per cubic second from the San Joaquin River for power purposes. The cost of the project is estimated at $4,000,000.

McFARLAND, CAL.—Steps have been taken by farmers in this vicinity to establish a community electric power plant, operated by steam power, using natural gas for fuel. The cost is estimated at about $250,000. Mr. Carter, a member of the McFarland Farm Center, is one of the promoters.

SAN FRANCISCO, CAL.—Application has been made to the State Power Commission by the Snow Mountain Water & Power Company for permission to appropriate 400 cu.ft. per second from the South Fork of the Eel River in Lake and Mendocino Counties for power purposes. The cost of the project is estimated at $3,000,000. The company has also filed similar application for appropriation of water from the same stream for municipal purposes, to supply Berkeley, Oakland and Alameda.

SAN FRANCISCO, CAL.—Extensions to the street-lighting system, to cost about $5,000, are planned.

BRIGHAM, UTAH.—The City of Utah is planning to rebuild its hydro-electric plant with an increase of 1,500-hp. capacity.

OGDEN, UTAH.—Application has been filed with the state engineer for permission to divert water from the Ogden River to be used in connection with the new hydro-electric plant to be constructed for irrigation purposes in Weber and Boxelder Counties, and to have a capacity of 5,000 hp. O. D. McKay of Ogden is engineer.

WINNETT, MONT.—C. B. Davis has been granted a franchise to construct and operate an electric light plant in Winnett.

LARAMIE, WYO.—At an election to be held soon the proposal to issue $60,000 in bonds for improvements to the electric light plant will be submitted to the voters.

DENVER, COL.—Plans have been completed by the Mineral, Metal & By-Products Company for the construction of electric smelting and refining works, to cost about $1,000,000, including the erection of a power house, a plant for electrical retorts, a combination electric smelter and refinery, etc. G. Rasmus is second vice-president and managing director of the engineering department.

Canada

ACTON, ONT.—Bids will be received by E. A. James Company, 36 Toronto St., Toronto, engineer, until May 13, for improvements to the waterworks to include electrically driven deep-well centrifugal pumps, to cost about $30,000.

TORONTO, ONT.—Contract has been awarded to Wells & Gray, Confederation Life Building, by the Canadian National Carbon Company and Prest-O-Lite Company of Canada, Ltd., joint owners, for the construction of two factory buildings, to cost about $450,000. Both plants will be equipped for electrical operation.

MONTREAL WEST, QUE.—Bids will be received by Charles I. Fraser, secretary-treasurer, Town Hall, Montreal West, Que., until May 20, for the installing of a complete underground system of wiring, with standard posts and lamps, for the lighting of streets as shown on plans and specifications which may be seen at the Town Hall.

MURRAY BAY, QUE.—The Murray Bay Power & Pulp Company is contemplating the construction of a power plant, to cost about $500,000.

THREE RIVERS, QUE.—Contract has been awarded to the Canadian Comstock Company, Ltd., for the furnishing and installing complete electrical and mechanical equipment in the pulp and paper mill of the Maurice Lumber Company, including motors, transformers, electrical feeders and distribution, etc. The total cost is estimated at $6,500,000.

Record of Electrical Patents

Notes on United States Patents

(Issued April 20, 1920)

1,336,932. RAIL BOND; William C. Starkey, Mansfield, Ohio. App. filed June 26, 1916. Applied by intense heat and protects flexible portion of bonds from heat. Time of contact is short and bond is made integral part of rail.

1,336,939. ELECTRIC FURNACE; Svend Barfoed, Berkeley, Cal. App. filed Sept. 25, 1916. Water-jacketed type.

1,336,940. RAIL BOND; John R. Brown, Mansfield, Ohio. App. filed Nov. 2, 1917. Bond secured by application of heat having terminal members of a higher melting point than body.

1,336,966. TROLLEY RETRIEVER; John Kozak, Milwaukee, Wis. App. filed Nov. 26, 1918. Readily applied to trolley poles of common construction without alteration.

1,337,062. OZONATOR; Milton W. Franklin, Bloomfield, N. J. App. filed Aug. 3, 1916. Machine produces a gaseous reaction by an electric discharge.

1,337,080. MULTI-CONDUCTING LEADS; Ward E. Krone, Pittsfield, Mass. App. filed June 16, 1919. Small power losses in dielectric insulating material employed.

1,337,100. ELECTRICITY TRANSFORMING AND CONVERTING APPARATUS; Charles W. Stone and Henry M. Hobart, Schenectady, N. Y. App. filed Sept. 6, 1916. Receives high-pressure polyphase current from a supply system and delivers relatively low-pressure direct current to a distribution system.

1,337,106. PROCESS OF MAKING NITRIC ACID; Elihu Thomson, Lynn, Mass. App. filed Dec. 6, 1918. Process and an apparatus for utilizing the solubility at low temperature of the nitric oxides in nitric acid.

1,337,120. ELECTRIC WATER HEATER; William F. Cutler, Oakland, Cal. App. filed May 5, 1919. Avoids use of large wires and heavy currents.

1,337,129. DISTRIBUTION OF ELECTRICAL ENERGY; Charles Grover, Gravesend, Eng. App. filed Oct. 24, 1919. System effects a more equal distribution of stresses of what are known as intersheaths or grading sheaths.

1,337,156. ELECTRIC FURNACE; Julius A. Pickens, Easley, S. C. App. filed June 14, 1919. Construction of the electrodes and combustion chamber whereby all substance treated is brought in contact with and forced to move through flame of an electric arc.

1,337,160. BATTERY TESTER; George H. Riebeth, Minneapolis, Minn. App. filed May 28, 1919. For testing dry batteries while contained in round or square cartons of usual type.

1,337,163. PROTECTIVE CASING FOR ELECTRIC METERS; Joseph J. Schickuna, Buffalo, N. Y. App. filed Jan. 25, 1915. Prevents tampering with wires.

1,337,189. VAPORIZING STOPPER; Ellsworth W. Austin, Plymouth, Conn. App. filed June 2, 1919. Contains resistance units.

1,337,197. TELEPHONE-EXCHANGE SYSTEM; Henry P. Clausen, Mount Vernon, N. Y. App. filed July 9, 1917. Variable adjusted phonograph device informs operator of desired number.

1,337,198. CALLING DEVICE; Henry P. Clausen, Mount Vernon, N. Y. App. filed July 12, 1917. Impulse senders for automatic or semi-automatic telephones in which selector switches are directively controlled by current impulses.

1,337,245. REHEALING PROCESS FOR CONDENSERS; Byron Macpherson, Roxbury, Mass. App. filed Nov. 19, 1919. Intermittently including condenser in a circuit to fuse a coil and heat dielectric at defective spot.

1,337,246. BUILDING STAND FOR CONDENSERS; Byron Macpherson, Roxbury, Mass. App. filed Nov. 19, 1919. For sheet or plate type.

1,337,284. TWIN-BAR SUSPENSION INSULATOR; Sol S. Sonneborn, Brooklyn, N. Y. App. filed July 10, 1918. Provides in combination with an insulator a spark gap.

1,337,285. AUTOMATIC SELECTING SWITCH; Arthur B. Sperry, New York, N. Y. App. filed June 6, 1918. Switch used as a trunk hunting or line switch.

1,337,297. TELEPHONE-EXCHANGE SYSTEM; Horace W. Ulrich, East Orange, N. J. App. filed May 11, 1918. Trunk circuit with a signal-control relay whose operating circuit is partially established upon connection being made with incoming end of trunk circuit.

1,337,299. ANNUNCIATOR; Eugene W. Vogel, Oak Park, Ill. App. filed June 20, 1914. Visible three signal mechanism.

1,337,301. TELEPHONE-EXCHANGE SYSTEM; Ray S. Wilbur, Lyndhurst, N. J. App. filed May 13, 1918. Private branch exchange switchboards joined by means of trunk circuits.

1,337,304. SPEECH-REPRODUCING DEVICE; George F. Atwood, Newark, N. J. App. filed June 22, 1917. Speech-reproducing device repeating telephone numbers or letters designating a telephone line.

1,337,305. PROCESS OF MELTING AND MELTING AND REDUCING METALS; Morris H. Bennett, Waterbury, Conn. App. filed June 26, 1918. Reduces the overheating of metals of the non-ferrous group by utilizing characteristic of high thermal conductivity.

1,337,309. TELEPHONE SYSTEM; Charles L. Goodrum, New York, N. Y. App. filed Feb. 26, 1916. Brush sets carried on same movable-switch element and employed in simultaneously hunting for a desired line.

1,337,310. TELEPHONE SYSTEM; Charles L. Goodrum, New York, N. Y. App. filed July 26, 1917. Electromechanical switching for extending a call from one subscriber's station to another.